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Chemical



THE
CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE:

(WITH WHICH IS INCORPORATED THE "CHEMICAL GAZETTE.")

A Journal of Practical Chemistry

IN ALL ITS APPLICATIONS TO

PHARMACY, ARTS, AND MANUFACTURES.

EDITED BY

WILLIAM CROOKES, F.R.S.

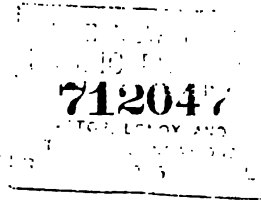
AUTHORIZED AMERICAN REPRINT, VOLUME III.—JULY, 1868, TO JANUARY, 1869.

NEW YORK:

W. A. TOWNSEND & ADAMS, PUBLISHERS.

M DCCC LXVIII.

9, 21, 11, 14.



VOLUME II., AMERICAN REPRINT,

BEING PARTS OF

VOLUMES XVII., XVIII., VIZ. NUMBERS 439-465,

OF THE ENGLISH EDITION.

WILLIAM
CLARK
HARRIS

THE NEW YORK PRINTING COMPANY,
81, 83, and 85 Centre Street,
NEW YORK.

P R E F A C E .

REFERRING to their Preface in each of the two preceding volumes of the American Reprint of the London CHEMICAL NEWS for information as to the general character and scope of the journal, the undersigned would now call special attention to the features they have introduced in the American issue. It is proper to say, that we purpose to make additions only—interfering with and modifying in no degree the reproduction of the English original.

In the December number is commenced the publication of a SUPPLEMENT TO THE CHEMICAL NEWS in the United States,—more especially devoted to American interests,—containing Notices of the current Progress of Chemistry and the Physical Sciences in America, Notices of New Books, Movements in Trade, etc. This new department will be under the editorial charge of Professor CHARLES A. SEELY, of New York, a gentleman abundantly qualified to execute in the best manner the task thus undertaken. In this feature, we comply with suggestions frequently made and for some time entertained, and we are confident that it will be accepted by the scientific public as an earnest of the pledge that nothing will be left undone to give to this Reprint such a place, as its intrinsic character merits in the esteem of the community.

The Price-Current of drugs, dyes, glassware, naval stores, oils, paints (dry and in oil), spices, and window-glass at Jobbers' Prices, is found to answer all we had hoped to secure, in giving to the publication a commercial as well as scientific interest. It will be faithfully corrected, monthly, by competent authority, furnishing a reliable record of current prices in the New York markets.

W. A. TOWNSEND & ADAMS.

DECEMBER, 1863.

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THE CHEMICAL NEWS

AND

JOURNAL OF PHYSICAL SCIENCE.

American Reprint. Volume III. July, 1868.

TO WHICH IS ADDED

The American Druggists' Price-Current.

ON THE ESTIMATION OF SULPHUR IN IRON AND ITS MINERALS.*

BY M. W. EGGERTZ,

PROFESSOR AT THE FAHLUN MINING SCHOOL.

As small quantities of sulphur, even a few ten-thousandths, are sufficient to render iron, even of excellent quality, red-short and unfit for certain uses, it would be very useful to be able to ascertain the quantity of sulphur which exists in the iron, not only with the necessary scientific exactness, but also with a facility and accuracy suitable for practical wants. But as the methods ordinarily employed for this purpose, especially on the score of facility, leave much to be desired, I have been engaged for several years in improving the known processes, and I wish to communicate in these pages the results of my researches. I have found in this difficult work, especially in the estimation of sulphur in iron analytically, useful aid on the part of M. J. E. Sieurin, and some other students of the Mining School, but I must especially mention the valuable services of M. J. F. Lundberg.

A. Detection of sulphur by means of chloride of barium.

1. Iron.—5 grammes of iron passed through a sieve with apertures of 0.6 m.m., are added to a solution of 10 grammes of pure chloride of potash, free from sulphate, in 200 cubic centimetres of distilled water, and contained in a flask of a capacity of 500 c.c. Cover this flask with a small funnel and heat the contents on a sand-bath to complete ebullition; then add gradually 60 c.c. of hydrochloric acid of the specific gravity 1.12.

It is best to add the hydrochloric acid at first drop by drop from a burette, as otherwise a strong disengagement of gas would take place; but in proportion as this evolution diminishes larger quantities of acid may be added; ordinarily half an hour is required for this operation, and during this time the solution ought to be kept in complete ebullition, so that no sulphuretted hydrogen gas escapes. Then allow the liquid to boil gently for five or six minutes more. In this way the carbon and part of the silicic acid remain insoluble, and often also a brown flocculent or pulverulent substance resembling hydrated oxide of iron, which is composed of a gey product analogous to humus, which is formed from the carbide of iron. During the solution a little sulphur is also sometimes separated; it swims on the surface. To oxidise this sulphur and drive off the chlorine and hydrochloric acid which are

present in the solution, it must be evaporated to dryness in a water-bath; the sides of the flask and the small funnel which covers it should always be first well washed with a jet of distilled water.

If there is much sulphur on the surface the moment it has disappeared the funnel should be replaced by a paper cover. When the solution has become syrupy the desiccation should be hastened by stirring it well with a glass rod. Add to the dry mass 10 c.c. of hydrochloric acid and 30 c.c. of water, and then leave the mixture on the water-bath until all the crystals of chloride of iron are dissolved, then add about 20 c.c. more water, and collect the insoluble portion on a filter, washing it perfectly with warm water. It sometimes happens that during the washing the organic matters remaining on the filter dissolve and precipitate again in contact with the acid solution, but they are easily redissolved on boiling the liquid. The last washing water ought to have no acid reaction; evaporated and heated to redness on platinum foil it should leave no trace of residue.

The filtered liquid, whose volume is about 50 c.c., should be rapidly boiled and mixed with 2 c.c. of a saturated solution of chloride of barium. (This amount is sufficient to precipitate the sulphuric acid formed from 0.1 grm. of sulphur). After cooling add to the mixture 5 c.c. of ammonia sp. gr. 0.95, then stir well with a glass rod, and leave the whole to rest at the ordinary temperature for twenty-four hours. The clear solution should be decanted as completely as possible on to a strong filter, and the precipitate stirred up with about 20 c.c. of cold water, and then left to itself until it has quite settled. If warm water is used without having added a few drops of hydrochloric acid, a little oxide of iron will precipitate. The clear liquid is likewise thrown on to the filter, and the operation is repeated several times with cold water, and then two or three times with boiling water, with out which precaution the sulphate of baryta will pass through the filter. Finally collect the precipitate, and wash it carefully with warm water. The last drops of this water on being evaporated on a watch-glass ought not to leave more than a scarcely visible white ring. The precipitate is then dried, heated to redness, and weighed. If it is coloured with oxide of iron it must be washed with a little hydrochloric acid, dried in the water-bath, and taken up with a few drops of acid and water, and then the preceding operations repeated (washing, drying, heating, and weighing). If the precipitate has only a feeble red colour, which is often the case, this latter operation will be unnecessary.

100 parts of sulphate of baryta contain 34.3 parts of

* *Moniteur Scientifique.*

experiment 5 grms. of iron have been used, each 0'001 grm. of sulphate of baryta will correspond to 0'00274 per cent. of sulphur in the iron.

ON THE MANUFACTURE OF GLASS.

BY HENRY CHANCE, M.A.

Abstract of a Lecture delivered at the Chemical Society, March 19th, 1868.

REFERRING to the raw materials of which glass is made, the various qualities of sand were in the first place described. The American sand is considered the finest of all; then that from Fontainebleau; Belgian next; and, of English samples tolerably free from iron, the deposits occurring at Leighton Buzzard were in great demand. This quality is, indeed, almost exclusively employed by the Messrs. Chance, and, though of a yellowish tint, contains less iron than many whiter samples. Sand of a strong reddish hue may be made nearly white by calcining it with a small quantity of common salt. The Welsh sand is not held of much account, for it seems to produce glass in which striae abound.

With respect to the alkaline ingredients for glass-making the use of kelp, soda of alicant, and Egyptian natron, were briefly noticed, and the influence of Le Blanc's discovery traced. The substitution of the sulphate for the carbonate of soda—due to Gehlen—tended to cheapen the glass, but at the sacrifice of quality; for the best kinds of plate glass the carbonate (soda ash) is always employed. For the common blown window glass the sulphate answers well: it will permit the use of larger charges of lime, and the glass produced from it is harder, takes a better polish, is less liable to devitrification, and to the alteration of its surface by what is termed "sweating." The addition of carbon in the form of charcoal, or powdered anthracite, facilitates the reduction of the sulphate, and tends to promote vitrification. Only one atom of carbon is, in practice, found sufficient for two atoms of sulphate of soda. The object of its employment would, then, seem to consist in furnishing the means of reduction of a part only of the alkaline sulphate to the state of sulphite, and not to sulphide; the decomposition of the sulphate is further facilitated by a liberal use of carbonate of lime, the action of which is not clearly intelligible. Glass made from sulphate of soda is of a bluish, whilst that made from the carbonate is of a yellowish tint. When an extra pale colour is desired, the carbon is kept at a minimum, and the lecturer once saw, at glass works in the north of France, an expedient practised in this direction, which consisted in employing the sulphate in large excess, and lading off the upper layer of this fused salt whilst the pots stood in the furnace. Should any of this ingredient be accidentally left in the crucible, "salt-blisters" are formed.

The lime required for the crucible charges is introduced in the form of quick-lime when carbonate of soda glass is made; but for the other kind either chalk or limestone, preference being given to the latter, probably on account of its containing some carbonate of magnesia. This addition of lime is in flint glass replaced by oxide of lead, giving great lustre and refracting power, but if made into sheet would be full of striae. Pipe clay and alumina are sometimes used in glass-making, but are not supposed to improve the quality; all glass fused in clay pots must necessarily contain more

or less alumina, and it has been noticed that the outer portions next the crucible often show irregularities, and occasionally some coarse gritty particles become detached from the inner surface by corrosion of the finer clay under the action of the fused alkali. Chloride of sodium excepted, no appreciable amount of alkali is lost by volatilisation in the furnace; at any rate, the deficiency from all sources of waste, including the mixing, decrepitation on first heating, &c., never exceeds 1 per cent.

The average composition of different qualities of glass was stated to be as follows:—

Crown and Sheet Glass.

	English.	Foreign.
Silica.....	73	74
Lime.....	13	14
Soda.....	13	11
Alumina, oxides of iron, and maganese..	1	1
	100	100

Ancient Glass.

	12th century.	16th century.
Silica.....	51'60	54'60
Alumina.....	2'16	8'96
Protoxide of iron...	1'58	0'75
Lime.....	8'04	19'31
Magnesia.....	2'22	3'43
Alkalies.....	34'40	12'95
	100'00	100'00

The use of peroxide of maganese and arsenious acid in glass-making is mainly for the purpose of effecting the peroxidation of the iron, which in this state has far less colouring property. The author here pointed out as an anomaly the circumstance of carbon and metallic oxides being employed in the same mixture, but an attempt to defer the addition of the latter until the carbon had done its work was only partially successful, since it is difficult in the last stages to insure a proper incorporation of the materials. The Belgian manufacturers are said to have discontinued the use of the above metallic oxides. The purest coloured flint glass is composed of sand, potash, and oxide of lead. For some kinds of optical glass a portion of the red lead is replaced by lime, and if the lead is used in excess the heavy flint glass produced has a strong yellowish tint. When much maganese is employed to correct the colour arising from impurities in the glass mixture, there is a tendency for the glass to undergo changes of colour on exposure to sunlight; and a greenhouse roofed with glass in which maganese has been used will often display, after a lapse of time, a great variety of tints. Reference was then made to Mr. Gaffield's experiments on the action of sunlight upon glass, and to the practical conclusion arrived at, to the effect that the alteration in colour was solely due to the different states of oxidation of the maganese. The lecturer further asserted that he had noticed changes of colour in glass which did not contain a trace of this metallic oxide, and specimens were exhibited in which the glass, originally white, had become strongly tinged with yellow. In connection with the employment of Siemen's regenerating furnaces at his works, Mr. Chance stated the following particulars. The cubical capacity of the glass furnace was about 1800 feet (or 20 feet long, 10 broad, and 9 feet high). This chamber accommodated eight large clay melting-pots, each of which was capa-

ble of producing two tons of refined glass in five and twenty hours. The saving on Siemen's plan was, firstly, the difference in cost between large coal and slack; and, secondly, a more cleanly manipulation, whereby a superior product was obtained in open pots. By way of conclusion the lecturer described Gossage's process for the manufacture of soluble glass, and the results of his own experiments on the fusion and devitrification of the basaltic rock known as "Rowley Rag." A large slab of the fused material, which is similar to black marble, and other specimens of the same devitrified, were exhibited.

TEST FOR BROMIDES.

BY SURGEON J. H. BILL, U. S. ARMY.

In conducting some investigations during the past summer, on the physiological relations of the halogens, it became absolutely necessary in the course of the experiments, to devise a ready and sensitive test for bromine in the presence more particularly of chlorine.

Any analyst will bear out the assertion—although the books make light of the matter—that it is a difficult thing to recognise traces of bromine in the presence of excess of the other halogens. Thus in the case stated above, it was found impossible to obtain by the ordinary methods of the books, a certain and easy recognition of bromine when chlorine was present.

The Fresenius test solution of auric chloride produces in faintly acid solutions of alkaline bromides, a colouration ranging from dark orange red to light straw colour, according to the strength of the solution. Iodides must be out of the way. Chlorides, however, do not interfere in the least. The following is the best way of applying the test:—Separate iodides by palladium, and after getting rid of excess of palladium by sulphuretted hydrogen, concentrate the solution to about twenty-five cubic centimetres. Select two test tubes, of the same size and shape, and colour of glass. Into one pour the solution suspected to contain bromide. Into the other pour pure water, adding perhaps a trace of chloride potassium; add now to each test tube a drop of chlorhydric acid, and then to each one drop of auric chloride solution. On now comparing the two tubes particularly in the direction of their long axes, a yellow colour will be observed in the tube containing the bromide, and made very manifest by comparison with the other tube.

The following experiment shows the delicacy of the test applied as above:—One centigramme of potassic bromide was dissolved in one thousand cubic centimetres of water. Thirty centimetres of this solution, compared with thirty centimetres of a very weak solution of potassic chloride, gave a decided yellow colour. This experiment was varied by dissolving a gramme of potassic chloride in two thousand cubic centimetres of water, halving, and adding one centigramme of potassic bromide to the one half. Thirty centimetres of each of the two solutions now tested, gave ample evidence of the presence of bromide.

The mixed chloride and bromide should be brought to the state of salts of the alkalies if necessary, by precipitating with argentic nitrate, thoroughly washing, and fusing with potassic carbonate. If sodic carbonate is used, the subsequent reaction with the gold test is not so decided.

A test for chloride in the presence of bromide, as

simple and delicate as the above, is much needed. The writer has sought long for it but in vain.—*Am. Journ. Science*, March, 1868.

ON THE CHEMISTRY OF THE BESSEMER PROCESS.*

ANALYSES representing each successive step in the Bessemer process do not appear, as yet, to have been published. The following analyses of the raw material and the various products at different stages of this process were sent with the manufactured objects to the late Paris Exhibition from the Bessemer Works of Neuberg, in Austria. In the absence of more complete analyses, they may be of some value.

The charge was a good dark-grey iron, weighing 62 cwt. 80 lbs. (Austrian); it was transferred directly from the blast furnace into the converter. Blast was applied for 28 minutes under a pressure of 20 lbs. to the inch; at the close of this first period a sample of the iron was taken. During the second period, of 7 minutes, the pressure of the blast was 18 to 19 lbs. per square inch; the third period lasted only 3 minutes, under about the same blast. The amount of slag was a little larger than usual, probably because of the taking of samples from the mass. The analyses of the raw-iron and of the samples taken at the close of the above period, gave the following results:

1. The iron taken was dark-grey, graphitic, containing considerable silicon, very little phosphorus and sulphur, and much manganese; in every respect an excellent material for the Bessemer process. A small amount of copper was present, but not enough to either hinder the process or deteriorate the product.

2. At the close of the first period spoken of, all graphite had disappeared, partly by combustion, partly by combination with the iron; almost four-fifths of the silicon had been separated; all but a trace of sulphur had disappeared; the amount of phosphorus remained nearly the same; also the total amount of the copper, while its percentage was a little higher; much of the manganese was lost. The product at the close of this period was a pure white raw-iron, containing not overmuch of carbon.

3. During the second period the removal of the carbon progresses rapidly, so also the still remaining silicon and manganese are rapidly disappearing, while again the copper and phosphorus remain almost the same. The product at the close of this period of only about seven minutes was a good steel; according to the common scale, steel No. 3.

4. At the close of the third period, a steel No. 7 was obtained. The addition of 6 cwt. raw iron gave a Bessemer steel No. 6.

The slags obtained at the various stages were also analysed; they always contained a great relative amount of silica, but, both before and after the second (or "boiling") period, remarkably little of ferrous oxide. During the last stages of the process, the percentage of manganese in the slag decreases, because most of the manganese is removed in the first period, so that the increase of slag during the last stages of the process can only add iron to it, *i. e.*, reduce the percentage of the manganese. A little alumina and lime found in the slag is ascribed to the walls of the furnace.

* "*Aus der Natur*," 1867, p. 714, &c.

From the composition of the raw material and the final product, the amount of the various elements removed during the process is obtained by the difference of the first two quantities. The amount of oxygen necessary for this removal may easily be calculated on the supposition that the silicon is converted into silica, carbon into carbonic acid (CO), phosphorus to phosphoric acid (anhydride), sulphur to SO_2 or SO_3 ; iron to magnetic oxide (Fe_3O_4), of which but a small amount is found in the slag, the greatest portion being blown out in the shape of a red smoke (Fe_2O_3). The following table contains the results thus obtained:

	Raw iron taken. lbs.	Bessemer steel obtained. lbs.	Removed. lbs.	Requiring Oxygen. lbs.
Carbon,	258.59	12.79	245.80	327.73
Silicon,	128.97	1.80	127.17	139.07
Phosphorus,	2.63	2.40	0.23	0.29
Sulphur,	1.13	—	1.13	1.69
Manganese,	227.67	7.59	220.08	63.56
Copper,	5.59	5.59	—	—
Iron (by difference),	5956.42	5429.82	525.59	200.22
Total,	6580.00	5460.00	1120.00	732.56

	Producing lbs. of	
Carbon.....	573.53	CO
Silicon.....	266.24	SiO_2
Phosphorus.....	0.52	P_2O_5
Sulphur.....	2.82	SO_3
Manganese.....	283.64	MnO
Copper.....	—	—
Iron (by difference).....	725.81	Fe_3O_4

This amount of oxygen can be had in 43,330 cubic feet of atmospheric air, or 1,140 cubic feet per minute, or 660 cubic feet per cwt. of the charge.

The supposition that the carbon burns to carbonic oxide (CO) and not to carbonic acid (CO_2) seems to be proved by the spectroscopic investigations of Lielegg.

GRAPHITE IN CALIFORNIA.

THE principal plumbago deposit of California, known as the Eureka Black Lead Mine, is situated on the west side of Tennessee Gulch, a tributary of Wood's Creek, about $1\frac{1}{2}$ miles from Sonora, the county seat of Tuolumne county, and about 68 miles from Stockton, the head of navigation on the San Joaquin River. The mineral exists as a well-defined lode, from 20 to 30 feet wide, having a dioritic foot-wall on the west, and a soft clay-slate hanging wall on the east. The trend of this lode is nearly north-east by south-west, and it dips very irregularly to the east, at some places being nearly vertical, and at others nearly horizontal. It has been traced and explored for 3,900 feet, beyond which there are but faint indications of its existence. The whole deposit, including the walls and vein, is enclosed in the limestones peculiar to Tuolumne and the adjoining counties.

The graphite near the surface is much contaminated with the materials of the clay-slate, which rapidly decomposes on exposure to the atmosphere. It was this circumstance that delayed the development of the mine, as it was found impossible to separate the earthy matter from the more valuable plumbago. About two years since it was discovered that the graphite floated on water, when a simple apparatus was employed, which separates nearly 100 tons per day, giving em-

ployment to some 25 labourers to wheel the stuff from the mine to the arrastre, about 50 feet distant. This separating process is not now required, for in a large portion of the vein below the surface, at a depth of 40 feet, the graphite is cut out in solid blocks, and sacked without any further preparation; but it is divided by lenticular bodies of clay-slate, a few inches thick, and sometimes extended for several feet. This material is heavily charged with graphite, and is washed in order to separate it. At the depth of 60 feet the graphite is exceedingly solid and hard, with a very fine lustre. The whole material is taken out between the walls by an open cutting; all found not absolutely pure is washed, the other is bagged at once.

The product of the mine at present is about 1,000 tons per month, but is capable of an almost indefinite extension. The process of separating the graphite from the impurities is very simple. An inexpensive sort of large vat, with a stone bottom, 20 ft. in diameter, and 3 ft. deep, holds the materials, which are stirred up by iron rakes fastened to four cross-bars projecting from an upright shaft, moved by a water-wheel. When in motion a small stream of water passes into this vat, an outlet to which exists a few inches from the surface; through this outlet the graphite passes with the water, and is led by spouts into broad tanks, where it temporarily subsides, when the dirty water is run off, and a large stream of clean water forces the graphite into a series of shallow tanks, in which it is dried by the sun, the whole process requiring about five days to complete. The tanks and reservoirs at present used cover several acres. The cost of production of the solid plumbago at the mine does not exceed 4s. per ton, two men in the lower workings being able to extract 10 tons per day of solid graphite, in blocks of any desired size. The water used on the mine costs but £10 per month, which sum is more than realised by gold found in the vat when cleaning up, there being a thin seam of auriferous quartz between the hanging wall and the graphite occasionally passing into it. Lumps of gold, worth from 8s. to £4 each, are sometimes found imbedded in the graphite.—*Dicker's Mining Record.*

ON THE

EMPLOYMENT OF SAND AND GLASS FILTERS IN QUANTITATIVE ANALYSIS.

BY WOLCOTT GIBBS, M.D.,

HUMFORD PROFESSOR IN HARVARD UNIVERSITY.

SUFFICIENT attention has not been paid to the advantages of filters of sand and glass over those of paper, when precipitates are to be dried upon the filter at a definite temperature. By choking the throat of a funnel with coarse fragments of glass and then placing upon these successive layers of powdered glass or sand, the upper layer being of the finest powder, it is easy to make a filter upon which almost any precipitate may be filtered off and washed out completely without the slightest loss. The funnel with its contents may then be dried at any temperature below that at which the glass softens or at which the precipitate undergoes chemical or physical change. Mr. E. R. Taylor, who has carried out this suggestion with the greatest care and thoroughness, obtained the following results in three analyses of tartar-emetic:—

Grm. tartar-emetie.	Grm.	
I. 0.0917	gave 0.0463 Sb_2S_3	= 36.09 per cent. Sb.
II. 0.6236	" 0.3149	" = 36.08 "
III. 0.1766	" 0.0891	" = 36.07 "

The formula requires 35.92 per cent. (Sb=120).

In the first and second analyses the precipitated sulphide was dried at 375°C . In the third, the funnel had the shape of a tube tapering at one end and dilated in the middle to a sort of bulb, and the precipitated sulphide of antimony, after drying, was ignited in the filter tube itself in a current of carbonic acid gas. This form of funnel, which is due to Mr. Taylor, will be found very advantageous. A small common funnel may be inserted into the top, and after drying, the tube funnel closed with a cork in weighing.—*American Journ. Science*.

ON THE ESTIMATION OF NITRIC ACID. (PELOUZE'S METHOD.)

BY PHILIP HOLLAND.

Of the various processes from time to time proposed for the estimation of nitric acid in combination, there are three which may be said to be in some measure related, viz., those of Pelouze, Schloesing, and Walter Crum. In the two first the weighed nitrate is boiled out of contact with air with a solution of protochloride of iron and an excess of hydrochloric acid. Under these conditions the N_2O_5 splits up on the one hand into oxygen gas which indirectly by depriving the hydrochloric acid of its hydrogen admits of the conversion of the protosalt of iron into a persalt, and on the other into a lower oxide of nitrogen which escapes. The reaction being a definite one obviously affords two methods for estimating nitric acid. We may either determine the iron oxidised, which forms the basis of Pelouze's process, or we may after Schloesing reconvert the nitric oxide into nitric acid by the addition of oxygen, and titrate with an alkali in the usual manner. In Crum's method the nitrate together with a sufficiency of sulphuric acid to decompose it is agitated with mercury, whereby a reduction is effected with formation of nitric oxide as in the preceding instance. Of the three processes I have enumerated Schloesing's is valuable to the analyst, whose object it is to determine our acid when in the presence of organic matter; it does not appear to have come into general use, this is perhaps to be accounted for by the fact that the operations it involves are rather tedious, and somewhat difficult of execution. Since the method of Pelouze is extensively practised, a description of a simple apparatus for its successful prosecution may be interesting. Before I describe my apparatus I will notice the process as it stands at present.

What are its absolute requirements? Two; firstly, that the decomposition of the nitrate shall take place in an atmosphere of which oxygen does not form a part, and secondly that such decomposition shall be complete.

I need not describe the method as set forth in Fresenius; it is familiar to all. The author conducts the operation in a retort, through which he passes a current of hydrogen. Attached to the stem of the retort is a U-tube, containing a little water, which serves as a lute to prevent access of air.

In the modified arrangement I am about to describe, the operation is conducted in vacuo, and at its termination the solution is boiled to expel the nitric oxide, thus avoiding the necessity of employing either hydrogen or carbonic acid.

In the accompanying sketch, A, is a long-necked assay flask drawn off at B, so as to form a shoulder, over which is passed a piece of French india-rubber tube, p, about 6 centimetres long, the other end terminating in a glass tube, r, drawn off so as to leave only a small orifice. On the elastic connector p is placed a screw compression clamp. At c, a distance of 3 centimetres from the shoulder, is cemented with the blow-pipe a piece of glass tube about 2 centimetres long, surmounted by one of French tube rather more than twice that length. The elastic tubes must be securely attached to the glass by binding with wire. After binding, it is as well to turn the end of the connector back and smear the surface with fused caoutchouc, and then replace it.

This device is recommended by Dr. Sprengel for securing an air-tight joint. The wooden clamp e gives support to the flask; the rest of the arrangement requires no explanation.



The analysis of a nitrate is conducted as follows:—A small funnel is inserted into the elastic tube at c, the clamp at p being for the time open; after the introduction of the solution followed by a little water, which washes all into the flask, the funnel is removed, and the former placed in the inclined position it occupies in the figure. The contents are now made to boil so as to expel all air and reduce the volume of the fluid to about 4 or 5 c.c. When this point is reached a piece of glass rod is inserted into the elastic tube at c, which causes the water vapor to find egress through r.

Into the small beaker is put 50 c.c. more or less, of a previously boiled solution of protosulphate of iron in hydrochloric acid. (The amount of iron already existent therein as a persalt must be known).

The boiling is still continued for a moment to ensure perfect expulsion of air from r, the lamp is then removed, and the caoutchouc connector slightly compressed with the first finger and thumb of the left hand. As the flask cools the solution of iron is drawn into it, when the whole has nearly receded the elastic tube is tightly compressed with the fingers, whilst the sides of the beakers are washed with a jet of boiled water, which is also allowed to pass into the flask. The washing may be repeated, taking care not to dilute more than necessary or admit air. Whilst r is still full of water, the elastic connector previously compressed with the fingers is now securely closed with the clamp, the screw of which is worked with the right hand. Provided the clamp is a good one, r will remain full of water during the subsequent digestion of the flask.

After heating at 100° for half an hour the flask is re-

moved from the water-bath and cautiously heated with a small flame, the fingers at the time resting on the elastic connector at the point nearest the shoulder; as soon as the tube is felt to expand, owing to the pressure from within, the lamp is removed and the screw clamp released, the fingers maintaining a secure hold of the tube, the glass flame is again replaced, and when the pressure on the tube is again felt, this latter is released altogether, thus admitting of the escape of the nitric oxide through *r*, which should be below the surface of water in the beaker whilst these manipulations are performed. The contents of the flask are now boiled until the nitric oxide is entirely expelled, and the solution of iron shows only the brown color of the perchloride. At the completion of the operation the beaker is first removed, and then the lamp.

It now only remains to transfer the solution of iron to a suitable vessel, and determine the perchloride with chloride of tin in the usual way.

A mean of six closely approximating experiments for the percentage determination of N_2O_5 in pure nitre gave 53.53 per cent. instead of 53.41. The process is easy of execution, and gives satisfactory results. The points requiring attention are that the apparatus should be capable of retaining a sufficiently perfect vacuum during the operation; this condition is fulfilled by the use of suitable elastic tube and clamps. What is known as French tubing serves the purpose well; its sides are thick, and its material free from metallic oxides.

It is advisable when making the digestion at 100° to place the flask in cold water which is afterwards raised to the boiling point; if this be not done, but on the other hand the flask is heated at once, a violent bumping ensues, and portions of the liquid are projected into the tube at *c*.

I find it necessary to standardise the chloride of tin at the time the analysis is made; it appears to be liable to constant change. 10 c.c. of my solution originally equalled 0.4162 of N_2O_5 ; the second day the numbers were 0.3947; whilst on the third day 0.364 was a mean of two titrations. Particular precautions were not taken to preserve the solution, otherwise perhaps the numbers would not have presented so great a dissimilarity.

Chorley, April 23rd.

ON MUSICAL AND SENSITIVE FLAMES.

Abstract of a Lecture delivered, at the invitation of the Council, before the Dublin Royal Society, on January 3, 1868, by W. F. BARRETT, Natural Science Master at the International College, London, &c.

ONE of the earliest natural facts which arrests the attention of a thoughtful mind is the stability of the wonderful universe in which we live. This permanency is, nevertheless, the product of incessant change; for nothing is absolutely at rest. The secret of the stability of nature, its unresting repose, is found in the fact that the motion is regular—the change is periodic. Atoms, as well as planets, have their period of revolution. Hence, sooner or later, in the physical world at any rate, phenomena repeat themselves. Like a vast living body the throbbings of the universe announce the accord of its varied parts. This rhythmic flow of nature constitutes most literally the "Music of the Spheres." Not this, but a less ethereal music, I have had the honour of being invited to bring before you this afternoon.

The so-called musical or singing flames were discovered nearly a century ago by a native of this city, Dr. Higgins, who found that when a flame of hydrogen was burning within a glass tube the flame emitted a musical note. The experiment was repeated; and it was moreover shown that glass tubes were not necessary, for similar sounds, though of different quality, were produced when metal or pasteboard tubes were employed. Neither was it necessary to use hydrogen, for a small flame of common coal gas gave a musical note when burning within a tube.

The cause of this phenomenon had been investigated by many, but most successfully by an illustrious man who had lately passed from among us—a man who had left behind him a name as good as it was great, and who possessed a mind as simple and child-like as it was sagacious and profound—the late Professor Faraday. This subject had been one of Faraday's early *flames*. The cause was shown to be due to the fact that the gas, in issuing from the burner, did not burn silently. It rustled in passing through the orifice of the burner, and in burning it made a continuous series of inaudible explosions. This was proved by several experiments, for by suitable means both these causes could be exalted so as to become sensible. The resonance of the tube placed over the flame renders audible all the sounds of a certain pitch made by the gas. By a series of experiments it was then proved that any noise, if made regularly and with sufficient rapidity, was converted into a musical note. Thus rough and rude taps and hard and harsh explosions could be chased into perfect melody by mere rapidity of succession.

The condition of the flame when burning within the tube was shown by a moving mirror. It was seen that when the flame was silent, and the mirror moving, a band of light was produced, but when the flame was sounding, this luminous ribbon was broken up into a series of disjointed images of flame. The effect of lengthening the tube in which the flame was burning was next shown, and a series of gas jets burning within glass tubes of varying length gave a corresponding series of musical notes of varying pitch. By placing the finger upon the top of these tubes the sound could be quenched, and thus a novel musical instrument could be constructed. From glass tubes the lecturer passed on to show the effects of flames burning within extremely long tin tubes. Within a tube 6 ft. long, and about $1\frac{1}{2}$ in. in diameter, the flame of a large gas burner gave a loud unmusical roar. By adding to the end of this tube a glass chimney, it was seen that when the flame was sounding it was broken up into wild confusion. By enclosing a still larger gas flame from a huge Bunsen's burner within a tube 18 ft. long and 3 in. diameter, a deep roar was obtained, intermingled with loud reports similar to the discharge of musketry.

Returning once more to the gentler music of the small glass tubes, two flames, enclosed in their respective tubes, were taken and made to emit notes of the same pitch. This point was gained by shifting to and fro a paper slider, which moved stiffly at the upper extremity of one of the tubes. When the notes were nearly in unison a series of intermittent sounds or *beats* were obtained, due, as is well known, to the mutual extinction at certain intervals of the two sounds. Corresponding beats were obtained from two organ-pipes and two tuning-forks nearly in unison. One of these tuning-forks, mounted on its resonance case, being silent, the other, unmounted, was now struck, and its

prongs brought near to, but not touching those of the first fork; at first no sound could be heard, but by degrees the unmounted fork transferred its motion to the mounted one, and the sound of the latter slowly welled forth. The sound of the voice can thus be transferred to the strings of a pianoforte, and in the same way a flame can be made to accept and resound to a note of the proper pitch. This was illustrated as follows:—A singing flame, by adjusting the paper slider, was tuned to the note of a certain fork; the tube was then raised slightly, so that the sound could be quenched by momentarily placing the finger on the top of the tube. On now striking the fork, and holding it over a resonant jar, the flame instantly started into song. The same effect was shown by the syren, and also by the human voice. Retreating to some distance from the flame, the latter could be made to respond at pleasure, by pitching the voice to the proper note, whilst it remained utterly unaffected by any note not in unison with itself. Musicians would find such a flame a faithful monitor in training the voices of their pupils.

In the last experiment we have really a *sensitive flame*; but this name is now applied to another discovery, which was made in the following manner:—Two years ago (December, 1865), whilst engaged in some acoustic experiments, the lecturer had observed that every time a shrill note was produced, a tall tapering gas flame in his vicinity was singularly affected; the flame shrinking every time the note was sounded. That observation led to further experiment and enquiry, the result of which has been the discovery of the conditions of success for obtaining flames sensitive to the slightest sound. Some months after the above observation, Professor Tyndall took up the subject, and having largely added to its interest and importance, offered an explanation of the phenomenon in a lecture delivered at the Royal Institution, in January, 1867. At this lecture the discovery was first published, and the name given to "Sensitive Flames." Subsequently the lecturer had proposed a fuller explanation, and had discovered that not only flames, but all gases could be rendered extremely sensitive to sound—the track of the gas being marked by mixing it with smoke.* This historical notice would be unjust without referring to an observation made ten years ago in America by Professor Leconte. That physicist had noticed that certain sustained sounds in an instrumental concert caused a very perceptible movement of the ordinary gas flames in the room. This observation is really the germ of the more wonderful effects afterwards independently discovered by the lecturer. Though Professor Leconte was the first to publish the fact, in 1858, it appears that, previous to this date, artisans had frequently noticed the phenomenon as resulting from the shrill sounds of their work; and several musicians have informed the lecturer that the same effect has been one they have commonly observed.

Turning now from scientific history to experiment, the lecturer showed various kinds and degrees of sensitive flames. First, a "batswing" flame, which, under the ordinary gas pressure, moved slightly at the sound of a whistle, but thrust out long tongues of fire when the pressure was increased by urging the gas from a holder. This increased pressure was always necessary to obtain the more sensitive flames, for a reason that will be understood directly. A jet of gas, issuing from a V-shaped orifice, was shown to be quite insensible to

sound until the flame reached a height of 10 or 12 inches, and then, at the sound of certain high notes, the flame shortened and spread out into a fan-shape. Whistling to this flame in one key had no effect, while in another the effect was very marked. Playing an air upon a so-called bird-organ, the flame selected the high notes, and promptly shortened at their recurrence.

The probable cause of the sensitiveness of these flames was then alluded to. The impact of air evidently had nothing to do with the phenomenon. This was strikingly shown in the following experiment:—By tapping a membrane stretched over the mouth of a large tin funnel, a puff of air could be driven with such force from the narrow extremity that a candle was easily extinguished some 12 ft. away. Directing this puff of air against the sensitive flame, it was seen that the flame moved violently, but was utterly unaffected when the puff was driven either to the right or left. This should also be the case if in former experiments it were the impact of the air, and not the sound that produced the effect. But it was at once seen that when the lecturer whistled, at the same time slowly turning round, the flame still continued to shrink, and was almost as powerfully moved when the back was turned to the flame. The effect, then, is solely produced by the wave-like to and fro motion of the sonorous pulses. As first indicated by Professor Leconte, a gas flame, to be sensitive, has to be brought near its point of roaring; it then stands, according to Dr. Tyndall, as it were on the brink of a precipice, over which the sound pushes it. Agreeing with this explanation, that a sensitive flame is a body in a state of unstable equilibrium, the lecturer supplemented it by comparing the flame to a resonant jar; the flame, as was proved by a moving mirror, being in a state of rapid isochronous vibration when under the influence of external sound. The actual shrinking of the flame was due to an increase in the velocity of the current of gas, which was possibly brought about by an external sound throwing the pipe that conveys the gas into a state of vibration, which would thus narrow the channel of the gas passage: the change in the aspect of the flame being largely modified by the shape of the burner.

Whatever may be the complete explanation of the phenomenon, there can be no doubt that in a somewhat similar manner other objects besides flames are also sensitive to slight external impulses. Thus, many chemical compounds, as, for example, fulminating powders, are in a state of unstable equilibrium. The so-called "Rupert's Drop," which, when scratched, flew into a thousand fragments, is another instance of this kind; and some of the most eminent physicists are inclined to believe that the surface of our sun is in a somewhat analogous sensitive condition. From inorganic things we may travel on to organic, for we have evidence that there also exists in organised structures a more or less sensitive state at certain times. Thus, our wonderfully complex bodies, by disease or nervous derangement, are often thrown into an abnormal state, and when in that condition are sensitive to the slightest stimuli, if of the proper kind. This may possibly be the foundation for whatever truth there is in the science of homœopathy, the body being sensitive to a feeble influence, similar in kind to the disease under which it is suffering.

Here some may ask—"Of what good are these speculations, and to what practical end can these experiments be turned?" This observation, permit me to remark, is wholly improper. There is something nobler in life

* *Philosophical Magazine*, March and April, 1867.

than the accumulation of wealth, and a higher end to experiment than its mere monetary value; for all accession to knowledge must finally benefit the world. This ever intrusive exclamation *cui bono* is a serious check to the advancement of knowledge, for it disheartens those who are making nature yield up her secrets, and it damps the ardour of every searcher after truth. Allow me to illustrate my meaning. Imagine that when enchanted by the performance of some well-executed opera or oratorio, a companion by our side were to say—"Well, after all, of what good are these fine sounds: to what practical end can you turn this music?" Should we not instantly condemn a speech so characteristic of a sordid and sensuous mind? And when the student of nature is listening with admiration and even awe to the sweet, though silent, music sung to him by every object of his diligent study—by air and water, by flowers and flames—he is conscious that he bows before an oratorio as far above that of Handel as the works of the Creator are superior to the composition of the creature.

Still, however, the lecturer was enabled to show a practical application of these sensitive flames. Attention was drawn to the fact, that the flame shortened and spread out laterally under the influence of a whistle. Advantage was taken of this peculiarity to construct an instrument which may be turned to some practical use. The instrument consists of two sliding brass rods, *b b'* (see diagram); attached at right angles, to the summit of one is a compound metallic ribbon, consisting of thin layers of silver, gold, and platinum, welded together.



This arrangement expands unequally by heat, by so doing it swerves aside, and is thus brought into contact with a platinum point projecting from the top of the second brass rod, which is fixed about half an inch from the free extremity of the compound metallic ribbon. Connected with the two brass rods is an electric battery, associated with which is an electric bell, placed in a far distant part of the room. The bell will immediately ring if the electric circle be complete, but at present there is a gap in the circuit between the metallic ribbon and the platinum point. "I now ignite," said the lecturer, "a sensitive flame, which, in its ordinary state, burns at about 2 inches from the compound metal ribbon. I retreat some thirty feet from the flame, and whistle; the flame at once responds; it shrinks and spreads out sideways. By so doing it comes in contact with the metal ribbon; the latter instantly springs aside at the warm touch of the flame, strikes against the platinum point, completes the electric circuit, and there you hear that distant bell answering me every time I whistle." In the same way, at any hour of the night, the crying of a child in its cot would automatically announce itself in its parent's room. By a somewhat similar arrangement, using, however, a different burner, a burglar, filing the iron-cased doors of a jeweller's shop could be made to sound an alarm bell; and it is even possible, by making use of the propagation of sound through water, the reflection of that sound through a trumpet

immersed in the water, and its conduction to a sensitive flame, shut out by non-conductors of sound from the noises on board ship, that an arrangement might be constructed by which the approach of a vessel in a fog might be detected by ringing a bell in the captain's cabin. It is not, however, my province to develop these suggestions, which may, I trust, by the practical mind be in some way turned to the public good.*

The lecturer had reserved for the conclusion a flame wonderfully sensitive to the slightest noise. The burner which gave this flame was formed of steatite, and consisted of a single circular orifice, through which the gas was forced from a large holder in the lecture-room, with greater pressure than could be obtained from the main. The flame was now fully 2 ft. in length, and observe, said the lecturer, how delicate and fragile a thing it appears to be; for at the slightest noise it drops down a foot.† The jingling of this bunch of keys, the crumpling of this paper, the dropping of a small coin, are more than sufficient utterly to break up its height and symmetry. This flame makes no response to the vowels, O, U, nor to the labials, but it energetically responds to the sibilants. Repeating the stanza—

"Roll on, O roll for ever!
Rest not, lest thy wavelets
Shine as shining silver—
Shrink and sink to darkness."

The flame is unmoved by the first line, but emphatically bobs at the sound "rest" and "lest," and admirably suits its action to the words of the last line, for, when shrinking, the light of the flame almost disappears. So sensitive is this flame, that even a chirp made at the far end of the room brings it down more than a foot. Like a living being, the flame trembles and cowers down at a hiss—it crouches and shivers as if in agony at the crisping of this metal foil, though the sound is so faint as scarcely to be heard; it dances in tune to the waltz played by this musical box—and, finally, it beats time to the ticking of my watch. How wonderful are all these facts! And the more we know of them the more wonderful do they appear; for this astonishing change in the aspect of the flame is produced by an infinitesimal portion of those almost inaudible sound-waves, already enfeebled by their distance from the flame. Looking back on these, and innumerable other wonders revealed by physical science, and looking forward on that vast region which remains to be explored, do we not feel ourselves sinking to utter insignificance by contemplating the mysteries by which we are surrounded; whilst at the same time are we not conscious there is that within us still more wonderful than that without—a consciousness which lifts itself above all phenomena, grand and mysterious though they be?

* Several of the laws of acoustics may be illustrated to a large audience by means of the sensitive flame next to be described. Placing, for example, a watch in the focus of one concave mirror, and a sensitive flame in the focus of a distant second one, the reflection and convergence of sound is seen by the regular beating of the flame to every tick of the watch. The decay of sound, and the prevention of that decay by tubes, can also be shown in a similar way. Many other illustrations of acoustical phenomena at once suggest themselves. I hope shortly to publish some further applications of this novel *phenoscope*.—W. F. R.

† It is easy to see how a modification of the instrument just described can be, and has been, applied to this flame. The diminution of heat arising from the falling of the flame can cause the compound ribbon now placed above the flame, to recoil upon the other battery connection; or, another arrangement may be employed, an air-thermometer having a bent stem, in which are sealed asunder platinum terminals; the circuit being closed by the backward movement of mercury in the tube, owing to the contraction of the air in the bulb.

EGG-ALBUMEN, FROM A CHEMICAL POINT
OF VIEW.

BY JOHN SPILLER, F.C.S.

On a recent occasion it has been proposed to employ the white of egg in a naturally moist condition as the standard of comparison in estimating the quality, or degree of impurity, of potable waters, as regards their nitrogenous organic constituents. Variations in the amount of nitrogen contained in the white of egg have, however, been admitted, and the proportion of water, or, in other words, the weight of dry albumen, is suspected to be subject to variation. Whilst engaged in some experiments upon this new method of water analysis, in which, as I have said, albumen is taken as the starting point, and its nitrogen (or a known fraction of it) is evolved and estimated in the form of ammonia, it appeared to me desirable at once to ascertain whether or not the moist contents of the egg lost water by evaporation through the calcareous shell; for if this be the case to any appreciable extent, the constitution of the albumen within cannot possibly remain for any length of time fixed and definite, although the egg itself may, during this period, be perfectly preserved from organic decomposition.

My affirmative anticipations on this point were based upon the circumstance that a new-laid egg exhibits no cavity on breaking the shell, whilst a stale one always contains a considerable air-space; however, to set the question at rest, I made the following experiments:—The weight of a hen's egg was exactly taken, and it was then supported upon a wire tripod-stand, so that the air might have free access to the whole external surface of the shell. Upon weighing the egg after an interval of twenty-four hours, it had lost exactly one grain, and this ratio of loss by evaporation remained tolerably constant during several days. As, however, the experiment was made in the winter time, and during a season of wet weather, I repeated it under somewhat modified conditions. Two new-laid eggs of large size were taken, and, after their weights had been accurately determined, they were supported in a similar manner within a bell-jar, resting on a flat glass plate, with a dish of concentrated sulphuric acid to absorb the water given out by the eggs. The whole arrangement (that is to say, the desiccator and its contents) was placed in a room the temperature of which was maintained pretty uniformly between 55° and 60° Fahr., and there left for six weeks, the diminution of weight being frequently observed during this interval. In all, ten weighings were taken, and the results proved that 100 gr., or more, of water can be abstracted under these circumstances, whilst the loss in the intermediate periods followed a diminishing scale, but nearly coincided with the several intervals of time. The average loss of water by evaporation through the shell may be stated, for the two eggs operated upon, to have been at the rate of 2 and 2½ gr. respectively per diem. Upon breaking the eggs at the end of six weeks, one was found perfectly sweet and good, with the envelope of the yolk unbroken, but the second and smaller one was discoloured next the shell, and the albumen had become slightly decomposed. The last results with this egg were consequently disregarded.

The details of the experiments are quoted, for they serve to show the proportion of yolk to white at the final stage; ratio of water evaporated to total liquid contents; and the exact weight, in each instance, of the

shell with its lining membrane, after careful washing with dilute ammonia and subsequent drying in the air:—

Egg—No. 1.

Original weight (entire).....	975.0 gr.
Loss of weight in six weeks (water).....	100.0 "
Shell and membrane.....	99.2 "
Yolk.....	317.2 "
White (by difference).....	458.8 "

Egg—No. 2.

Original weight (entire).....	930.6 gr.
Loss of weight in three weeks (water).....	41.6 "
Shell and membrane.....	85.2 "
Yolk and white.....	803.8 "

It will here be noticed as an anomaly that the heavier shell of No. 1 egg permitted a faster rate of evaporation through its substance than No. 2. The latter appeared, however, upon inspection, to have a smoother external surface, and to be stronger and more compact in structure throughout.

The following table shows the actual amount of water lost by evaporation in the two instances for the intervals of time specified in the first column:—

Loss of Weight in Desiccator (Water evaporated).

Intervals of time. Days.	No. 1 Egg. Gr.	No. 2 Egg. Gr.
1.....	3.4.....	2.6
2.....	6.9.....	4.7
7.....	17.3.....	14.0
14.....	34.3.....	27.6
21.....	51.1.....	41.6
42.....	100.0.....	—

Ratio of Water Evaporated to Total Liquid Contents of
the Egg (per cent).

Time.	No. 1.	No. 2.
In two weeks.....	3.9.....	3.3
three ".....	5.8.....	4.9
six ".....	11.4.....	—

It would be difficult to prove whether or not the water lost by evaporation from the white is partly compensated by an accession of water, by diffusion, from the yolk. No colouring matter travels outwards unless an organic decomposition sets in, when all the natural barriers are destroyed, and the several parts of the egg become merged. I am inclined to think that this redistribution of water actually occurs, since the *sac* of the yolk appears wrinkled in a stale egg, as though by loss of a portion of its liquid contents.

The composition of fresh egg-albumen may be said to vary between the following limits:—

Water.....	88 to 85 per cent.
Dry albumen (containing nitrogen 1.55 to 1.75 per cent.).....	12 to 15 "

Other analyses have been recently published, in which the nitrogen amounts to 1.81 per cent. and upwards, with the minimum proportion of water. It is probable that these latter results were obtained with eggs which had been longer kept in stock.—*The Photographic News*.

RELATIVE VALUES OF FRENCH AND ENGLISH
WEIGHTS AND MEASURES.

BY A. A. FESQUET.

I SEE in the column of Notes and Queries (*American Reprint*, March, 1868, page 155) that one of your read-

ers wishes some calculations showing the relative value of French and English weights and measures. Tables for this purpose are to be found in many technical works, but I think they are not so complete as those I join to this letter. You will see by the number of different values of the gramme, and of the carat weight, that "the doctors of the standards disagree."

The value I have adopted for the gramme is 15'438-395 troy grains, calculated from 1 pound avoirdupois = 7000 grains = 453'4148 grammes.

It may be that these data, or my calculation, are incorrect; if so, I wish to be corrected. It would be a satisfaction to many of your readers to know the exact value in grammes of the English standard pound avoirdupois, and how many troy grains it contains. Most authors say 7000 grains; however, I have seen 7004 grains printed somewhere.

The use of the metric system is extending more and more; but the abbreviations in writing are not always short and corresponding to the simplicity of the system; therefore I have added to the tables a series of symbols for abbreviations, which will be understood by looking at them. This system is based on the same principles followed in chemical symbols. Each unit and its prefixes are indicated by their first letter, with this difference, that a capital letter is used when the prefixes are those increasing the unit.

We use already: kgm. = kilogramme; we might have as well, kg°. = kilogramme degree, g = gramme, instead of gm. or grm.

Philadelphia, March 23rd, 1868.

TABLES

SHOWING THE RELATIVE VALUES OF FRENCH AND ENGLISH WEIGHTS AND MEASURES, &c.

MEASURES OF LENGTH.

Millimetre	=	0'03937	inch
Centimetre	"	0'393708	"
Decimetre	"	3'937079	inches
Metre	"	39'37079	feet
"	"	3'2808992	feet
"	"	1'093633	yard
Decametre	"	32'808992	feet
Hectometre	"	328'08992	"
Kilometre	"	3280'8992	"
"	"	1093'633	yards
Myriametre	"	10936'33	"
"	"	6'2138	miles

Inch ($\frac{1}{36}$ th yard)	=	2'539954	centimetres
Foot ($\frac{1}{3}$ rd yard)	"	3'0479449	decimetres
Yard	"	0'91438348	metre
Fathom (2 yards)	"	1'82876696	"
Pole, or Perch ($\frac{1}{4}$ th fathom)	"	5'02911	"
Furlong (220 yards)	"	201'16437	"
Mile (1760 yards)	"	1609'3149	"
Nautical mile	"	1852	"

SUPERFICIAL MEASURES.

Square millimetre.....	=	$\frac{1}{1550}$ th of a square inch	
" ".....	"	0'00155	" "
" centimetre.....	"	0'155086	" "
" decimetre.....	"	15'5086	" inches
" ".....	"	0'10769	" foot
" metre or centiare...	"	1550'86	" inches
" ".....	"	10'7698	" feet

Square metre or centiare	=	1'196033	square yard
Are	"	107'6'98	" feet
"	"	119'6033	" yards
"	"	0'098845	rood
Hectare	"	11960'33	" yards
"	"	2'471143	acres
Square inch	"	645'109201	sq. millimetres
"	"	6'45109	centimetres
" foot	"	9'2903	decimetres
" yard	"	0'836097	metre
" rod or perch	"	25'291939	metres
Rood (1210 sq. yards)	"	10'116775	ares
Acre (4840 " ")	"	0'404671	hectare

MEASURES OF CAPACITY.

Cubic millimetre	=	0'000061029	cubic inch
" centimetre, or millilitre	"	0'061029	" "
10 cubic centimetres, or centilitre	"	0'61029	" "
100 " centimetres, or decilitre	"	6'10295	" inches
1000 " centimetres, or litre	"	61'0295688	" "
" " " "	"	1'760773	imperial pint
" " " "	"	0'2200967	" gallon
Decalitre	"	610'295688	cubic inches
"	"	2'2009668	imp. gallons
Hectolitre	"	3'5317	cubic feet
"	"	22'009668	imp. gallons
Cubic metre, or stere, or kilolitre	"	1'308	cubic yard
" " " "	"	35'3171	" feet
Myrialitre	"	353'171	" "

Cubic inch	=	16'3855	cubic centimetres
" foot	"	28'3159	" decimetres
" yard	"	0'764520696	" metre

AMERICAN MEASURES.

Winchester, or U. S. gallon (231 cub. in.)	=	3'78585	litres
" " bushel (2150'42 ")	"	35'23603	"
Chaldron	"	(57'25 cub. feet)	1621'085

BRITISH IMPERIAL MEASURES.

Pint ($\frac{1}{4}$ gallon)	=	0'567932	litre
Quart ($\frac{1}{2}$ ")	"	1'135864	"
Imperial gallon	"	4'5434579	litres
Peck (2 gallons)	"	9'0869159	"
Bushel (8 gallons)	"	36'347664	"
Sack (3 bushels)	"	1'09043	hectolitre
Quarter (8 bushels)	"	2'907813	hectolitres
Chaldron (12 sacks)	"	13'08516	"

PETROLEUM FUEL FOR STEAM SHIPS.

THE considerations which should govern the discussion of the question of the substitution of petroleum in place of coal for the generation of steam may be classed under the following heads:—First, the comparative heating or steam-producing capacity of the two substances, weight for weight; second, the comparative cost, weight for weight; third, the comparative cost of attendance in the fire or boiler-room; fourth, the cost and durability of the apparatus necessary for burning the petroleum (under this head, with the retort system, the air-pumps for forcing air into the retort, and, if it is not by gravity, the pumps for forcing in the petroleum should be included); fifth, the comparative diffi-

culties encountered and space required in stowing the two fuels.

With respect to the comparative heating power of anthracite coal and petroleum, let us first mention their absolute theoretical steam-generating capacities; that is, if the combustible elements in both cases could be completely consumed, and all the heat thus generated be utilised in making steam. According to the accurate and elaborate experiments of the eminent chemists, M.M. Favre and Silberman, a pound of carbon completely burned, so as to make carbonic acid (that is, by combining with $2\frac{1}{2}$ lbs. of oxygen), will evaporate 15 lbs. of water from a temperature of 212° Fahr.; and similarly, 1 lb. of hydrogen, by combining with 8 lbs. of oxygen, will evaporate $64\frac{1}{2}$ lbs. of water from the same temperature. The chemical composition of petroleum is said to be $C_{15}H_{12}$; or, in other words, it is composed of 12 atoms of carbon and 12 atoms of hydrogen. As an atom of carbon exceeds an atom of hydrogen six times in weight, it is seen that in a pound of petroleum, 6 parts are carbon and 1 part hydrogen. The absolute theoretical evaporative power of a pound of petroleum, in pounds of water, from 212° , is therefore $\frac{1}{6} \times 15 + \frac{1}{6} \times 64\frac{1}{2} = 22\cdot02$ lbs. Allowing that there is 20 per cent. of noncombustible matter in anthracite coal, there remains in a pound $\frac{4}{5}$ of a pound of carbon; hence $\frac{4}{5} \times 15 = 12$ lbs., the weight of water that theoretically may be evaporated from 212° by a pound of anthracite, under these conditions. Consequently, the absolute heating power of petroleum is 1·835 times greater than that of a pound of anthracite.

Now let us look at the comparative cost: the average price of crude petroleum is about 21 cents per gallon, and coal about 5 dollars per ton: in other words, the petroleum costs 3 cents per lb., while the cost of the coal is $\frac{23}{100}$ of 1 cent. Hence, a pound of petroleum, while it has but 1·835 times more absolute heating power than a pound of anthracite, costs 13 times more than the coal; that is, the heat produced by petroleum costs over seven times more than the heat produced by coal. The greater cost of the petroleum is therefore decisive against its economical use as a steam fuel, and this, too, without considering the complication of the apparatus necessary for burning it. With regard to the comparative cost of the attendance on the fire, economy in this particular is decidedly in favour of the petroleum. It is probable that a steam vessel which requires, say 24 men in the fire room, could dispense with at least 14 of them by the use of petroleum.

So far, we have assumed that not only was all the heat generated that is attainable from the perfect combustion of the two fuels, but that the whole of this heat was utilised in the evaporation of water. It need scarcely be remarked that such results are quite out of the question in practice. The experiments carried on with the machinery of the U. S. gunboat, *Palos*, in Boston harbour, throw much light on the evaporative power practically attainable with the two fuels. The petroleum in these experiments was burned by the contrivance known as Foote's retort apparatus, and the result of these trials was, that if the evaporative power of the anthracite is represented by 1, that of the petroleum is 1·38—a result much inferior to that which we have shown is due to the combustible elements of the two substances. This, perhaps, is due to the fact that it is more difficult to completely burn a hydrocarbon fuel than it is to burn one composed almost wholly of carbon. If we modify the calculations we have before entered into, according to the results attained with the

experiments on the *Palos*, conducted under the immediate supervision of the petroleum retort inventor, it will be seen that the result is still further against the economical use of the oil as a steam fuel.

We have now to consider the cost and durability of the apparatus for burning the oil. As to the cost, let us look at the expense of applying the retort system to vessels of the *Wampanoag* class, which have 58 furnaces in their boilers. It is estimated that such an apparatus would cost at least 250 dollars for each furnace, or $250 \times 58 = 14,500$ dollars, and when to this is added the cost of the air-pumps for pumping air into the retort, the engines for driving them, together with the pumps for forcing the petroleum into the retorts, and the paraphernalia of cocks, valves, and pipes connected with this machinery, we think it is safe to assume that the application of the retort system to such a ship would cost at least 60,000 dollars. When we come to look at the durability of this apparatus, the case is still more strongly against the petroleum; and when the high temperature to which the apparatus is exposed is considered, it becomes evident that portions of it will require constant renewal. But the most fatal practical objection to the retort system remains to be mentioned: it is the deposition of carbon, coke, and incombustible matter within the retorts and pipes. In experiments with a retort apparatus, the pipes and passages became so choked in less than 48 hours that the fire went out, and could only be renewed by taking the fixture apart and cleaning it.

With regard to storing petroleum on board ship, another serious difficulty is encountered. A great portion of the crude oil evolves, at ordinary temperatures, an inflammable gas; and this gas, when mixed with atmospheric air, forms an explosive compound, which instantly takes fire when brought in contact with flame. Other samples do not evolve this gas until the temperature is raised from 80° to 100° Fahr.

These facts point out at once the extraordinary care that must be taken in storing this substance on board ship, in order to guard against accidents of the most frightful character. It therefore seems clear that a proper regard for safety demands that the tanks containing the petroleum should be immersed in water; when the weight of these tanks and cisterns is borne in mind, together with the bulk of petroleum and coal composition (a cubic foot of the former weighs 50 lbs., and a cubic foot of anthracite, as stored in bunkers, weighs 52·5 lbs.), and also their relative heating values, which may be set down as 1·4 for the former and 1 for the latter, it may be with safety assumed that there would be a saving in weight and space of not over 30 per cent. in stowage capacity by substituting the oil for the coal. It is therefore evident, from what we have said, that even assuming that the oil and the coal can be burned with equal facility, and with an equal degree of liability to derangement, in steam-boiler furnaces, the excess of the heating power of the petroleum over that of the oil is so very much less than its excess of cost, that there is not the slightest probability, as long as these ratios exist, of petroleum ever taking the place of coal as a steam fuel.

When we look at the great complication and danger that must be added to steam machinery in order to burn the oil, and the liability to derangement and the want of durability, it is not likely that any prudent steam navigation company would allow it to be employed in their vessels, even if they could find an engineer to recommend it.—*American Artisan*.

ON MONOCHROMATIC LIGHT.

BY HENRY MORTON, PH.D.,

PROF. CHEM. AND PHYS. UNIVERSITY PENNA.

THE difficulty of producing monochromatic light in great quantity prevents us from demonstrating satisfactorily many points of interest in connection with the composition of light, and the theory of vision. Coloured glasses placed in the path of powerful beams of white light are doubly unsatisfactory; they reduce the amount of light enormously, and, with few exceptions (*e. g.*, red glass coloured with gold), yield a beam of mixed colour.

The old experiments of snap-dragon, or the spirit lamp with salted wick, are admirable as far as they go, but yield a very faint light at best. Something far superior to this is furnished by the arrangement of a ring of cotton wick wound on a wire, and supported immediately over and around a large Bunsen burner, the wick being soaked with an aqueous solution of some flame-colouring salt. This plan in effect is suggested in Sir David Brewster's natural magic; but as the Bunsen burner was not then known, a less simple arrangement is described to perform the same office.

The drawbacks to this arrangement are: the trouble of adjusting the cotton wicks, the delay in changing to produce a new colour, and the brief duration and, to a certain extent, irregular amount of the effect.

After lighting, the burners increase their effect to a certain point, and then soon rapidly diminish in the intensity of their light.

When a large number of burners are to be used these difficulties become serious, and I have therefore devised the following arrangement, which has proved, on trial, thoroughly efficient:—The burners to be used, varying in number from 5 to 30, in different experiments, are enclosed below in a box with a single large entrance, opposite to which is placed an atomiser, operated either by steam or compressed air.

A spray of the colouring solution is thus mixed with the air supplying the burners, and their flames are thus tinged with the greatest ease, certainty, and intensity of effect, the whole action being entirely under control, and capable of being maintained indefinitely, while the change from one colour to another is effected by simply transferring the tube of the atomiser from one solution to another.

For experiments demanding diffused light, this apparatus is most satisfactory. Five large Bunsen burners, thus arranged, light up the lecture room of the Franklin Institute, which seats about 350 persons; and with 60 burners, arranged in two groups of 30, I expect to illuminate sufficiently, at my next lecture, the Academy of Music, which has 3,500 stalls. Of course in neither case is the light brilliant, but simply sufficient to show in the most distant portions of the room the peculiar effects of this light on the faces and dresses of the audience themselves. Any object near the flame is, however, brightly illuminated.

The stage being set with the most brilliant scenery and coloured decorations, suddenly illuminated by yellow light thus developed, the ordinary gas-light being turned down, presents an appearance of ghastly change, which soon, to the unprepared until seen, while sufficient light remains to permit of the audience to allow the audience to report the strange observation of metamorphosis upon their neighbours.

In certain experiments, however, it is necessary to have monochromatic light of great intensity and concentration.

This I have found could be furnished in the case of yellow light, to a certain extent, by substituting in the gas microscope or polariscope a soda-glass rod for the ordinary line cylinder, and so adjusting its position that the rays from the heated glass should be cut off from the lenses, and only the light of the yellow flame should reach them.

We can thus show, upon a screen five feet in diameter, the greatly-increased number of rings developed by a section of Iceland spar in monochromatic light.

With the spectroscope we can also project the sodium line on the screen, so as to be well seen by an audience of 500 persons. By afterwards producing the absorption-band due to the vapour of the substance, with the aid of a small Bunsen burner and iron spoon with sodium, and again showing the absorption-bands of nitric peroxide and of cochineal, the characteristic phenomena of spectrum analysis may be sufficiently illustrated, without the trouble and expense of the electric light.

We have, in fact, with a large and efficient battery at command, generally employed the above arrangement by preference.

The details of adjustment we will furnish, with pleasure, should any one think it of sufficient interest to ask for them.

ON THE PREPARATION OF MAGNESIA FOR RESISTING HIGH TEMPERATURES.

BY M. H. CARON.

ABOUT two years ago I briefly pointed out the advantages which would accrue to metallurgy from the employment of magnesia as a refractory material. I regretted, at the same time, the high price of this earth, the employment of which appeared likely to be confined to the laboratory. Now, circumstances have happily changed; recent modifications introduced into the manufacture of cast steel, and especially the employment of Siemens's furnace and Martin's process, absolutely demand more refractory bricks than those at present in use, irrespective of price. On the other hand, native carbonate of magnesia, which formerly cost 250 fr. the 1,000 kilos., may now be obtained at the price of 70 fr. delivered at Marseilles, or 100 fr. delivered at Dunkirk. Calcination at the place where the carbonate is obtained, may still further reduce its price.* I desire now to describe my processes for its agglomeration, which may be employed by the chemist for the ready preparation of refractory vessels of all forms; by the physicist to obtain pencils for oxyhydrogen lighting purposes; and also by the manufacturer, to replace, in some cases, fire-bricks which have become insufficient in carrying out different processes of heating.

The magnesia which I employ comes from the island of Elba, where it is found in considerable quantities as a native carbonate, white, very compact, and of great hardness. This carbonate contains traces of lime, silica, and iron; it is, besides, interspersed sometimes with serpentine and large plates of silica, which would diminish the infusibility of the substance, and render

* This preliminary calcination requires less heat than burning lime, and diminishes the weight of the carbonate one half.

it especially unfit for oxyhydrogen illumination if their removal is neglected (I will presently give the reason). These plates are, however, easily recognised, and may be readily separated, even in working on the large scale. In the case of refractory bricks, the presence of a small quantity of these foreign bodies would, at the most, give rise, under the influence of the highest temperatures, to a slight vitrification, offering no serious inconvenience.

Before powdering the carbonate, it is advisable to bake it at the temperature necessary for the expulsion of the carbonic acid; the material then becomes very friable, and may be pulverised more easily. It is then possible to separate the serpentine and silica, which do not become friable under the influence of heat. This preliminary treatment does not permit of the agglomeration of the magnesia, and even were this difficulty to be overcome, a temperature higher than that of the original calcination would cause an enormous contraction, producing fissures and alterations in shape, which would interfere with the use of this substance. It is, therefore, indispensable, before moulding the magnesia, to submit it to a very intense heat, at least equal to that which it is intended to support subsequently.

Thus calcined it is not plastic, its appearance is sandy, and compression does not cause it to acquire any cohesion; a mixture of magnesia, less calcined, imparts to it this quality. The quantity of the latter to be added necessarily varies with the degree of calcination of the two magnesias; it is scarcely one-sixth of the weight of that which has been exposed to the temperature of melting steel. It only now remains to moisten it with 10 or 15 per cent. of its weight of common water, and strongly compress it in iron moulds, as adopted in making artificial fuel. The brick produced in this operation hardens on drying in the air, and becomes still more resisting when it is subsequently calcined at a red heat. The same process would appear practicable, varying the form of the moulds, for obtaining crucibles of great capacity; but compression is difficult in large masses, as well as when the moulds have a large surface, as the magnesia adheres strongly to the sides. Although I have been able to obtain small crucibles for the laboratory, I do not consider this process adapted to make the large crucibles employed in steel melting. In this and other cases it is preferable to agglomerate the magnesia in the humid way.

To endow magnesia with a sort of plasticity, I have profited by a property of this earth pointed out in "Berzelius's Chemistry." When strongly calcined, and then moistened, it hardens in drying. This fact is doubtless due to a hydration which takes place without sensible increase of temperature. I have also remarked that when solidified in this manner the magnesia only loses the assimilated water at a high temperature. Then calcination not only does not disintegrate it, but on the contrary confers upon it a hardness and resistance comparable to those of ordinary crucibles after their baking. This being understood, the application of this fact is obvious. Thus, the magnesia to be employed in the manufacture of crucibles, should only be moistened, moulded into shape, dried, and then ignited. For the construction of steel melting furnaces, a paste of moistened magnesia should be plastered over the walls; it will become ignited in due course without any particular precautions being taken. It sometimes happens, however, either owing to the magnesia being too much or too little hydrated, or owing to its con-

taining siliceous matter, that the vessels before or after firing do not possess quite the desirable solidity; they should then, to acquire this, be simply moistened in a cold saturated solution of boracic acid, dried, and then fired as before. This operation does not render the magnesia more fusible: it only causes the grains of the substance to cohere more strongly together.

Magnesia, very pure, strongly calcined and finely pulverised, may be employed in the form of paste (*barbotine*) and yield the most delicate and translucent crucibles, as well as the sharpest and most complicated impressions. I am convinced that some time hence this earth will be advantageously employed in the ceramic art in spite of the difficulties of its moulding compared with those of porcelain paste.—*Comptes Rendus*, lvi. 839.

ON A NEW PROCESS IN MINERAL ANALYSIS.

BY FRANK WIGGLESWORTH CLARKE, S.B.

In the course of some experiments upon the alkaline fluorides, I found that the most refractory minerals, such as emery, chromite, tinstone, rutile, &c., were completely and easily resolved by fusion with a mixture of fluoride of sodium and bisulphate of potassa.

The operation is performed as follows:—One part of the finely pulverised mineral is mixed in a platinum crucible with three parts of fluoride of sodium, and upon the top of this mixture are placed twelve parts of bisulphate of potash, which may be either in powder or in small lumps.

Upon heating, the mixture boils up strongly, and after a while settles into a clear, tranquil fusion. The boiling is chiefly owing to the action of the reagents upon the mineral, and not, as might be supposed, merely to the influence of the bisulphate upon the fluoride. This is shown by the fact that, whenever the reagents are heated together without minerals, although some boiling takes place, the addition of a little powdered chromite or iron ore fully doubles the violence of the action.

In quantitative analysis it is necessary to keep the crucible closely covered in order to avoid loss from spattering; and to heat carefully, so that the mass may not boil over. The bisulphate should never be mixed with the fluoride and mineral, because a portion of the assay is then apt to escape action, being left on the sides of the crucible by the boiling of the mass; but should be placed upon the top of the mixture as above directed, as then the decomposition is complete. The mass obtained by this fusion is, in the case of some minerals, completely soluble in water. In other cases, basic salts are formed, which although insoluble in water, dissolve readily in hydrochloric acid. Almost all of the latter class may be rendered soluble in water by the following process:—The fused mass, after cooling without removal from the crucible, is treated with a small quantity of strong sulphuric acid, and again fused. The mass thus obtained is entirely soluble in water. There are exceptions to this rule, however.

I will now describe the results I have obtained with various minerals, and for the sake of brevity, will speak of the fusion with bisulphate and fluoride as fusion No. 1, and the subsequent treatment with sulphuric acid, as fusion No. 2.

Tinstone is completely resolved, giving a white mass almost entirely soluble in cold water. A very small quantity of stannic acid remains undissolved, however,

but by first treating the mass with hydrochloric acid and then adding water, complete solution is ensured. By rendering the solution *nearly* neutral, taking care, however, to leave a slight excess of sulphuric acid, then reducing the iron by sulphuretted hydrogen or hyposulphite of soda, and then boiling for some time, all the tin is precipitated in the form of stannic acid. If the ore contains tungstic, niobic, or tantallic acids, these also will be completely precipitated. A second fusion is of no advantage with tinstone. This is the only mineral which I have yet tested which was not completely resolved by this process, over an ordinary Bunsen's gas burner. This substance required the heat of a blast lamp.

Wolfram is entirely decomposed, affording a pale yellowish mass, partly soluble in water. Hydrochloric acid dissolves a part of the residue, but a white powder, probably the hydrate of tungstic acid, remains unattacked. Fusion No. 2 possesses no advantages with wolfram. I should not recommend the use of this process for the analysis of wolfram, as it is so readily decomposed by nitric acid. I made the experiment, however, because as wolfram is so often mixed with tinstone, it seemed to me necessary to know what the reaction would be.

Rutile.—This mineral is rapidly and easily resolved, giving a mass when cooled, of a yellowish white colour, and, as I obtained it, presenting a beautiful mottled appearance, being crystalline in structure, and in some parts nearly transparent, but opaque in others. This mass dissolved entirely in cold water, rendering a second fusion unnecessary. From this solution all the titanlic acid may be thrown down by boiling.

Niobite is decomposed with the greatest ease. The mass is pale yellow, and partially soluble in cold water, but a small quantity of niobic acid remains undissolved, even in hydrochloric acid. But it is always best to treat with hydrochloric acid, in order to dissolve any basic sulphates of iron that may be formed. Upon boiling the filtered solution, niobic acid is precipitated.

Fusion No. 2.—A larger proportion of the mass is soluble in water than with the first fusion, as no basic salts of iron are present.

Ilmenite is completely decomposed, giving a mass closely resembling that obtained from rutile. Cold water dissolves a large part of this, but leaves some basic salts which dissolve readily in hydrochloric acid.

Fusion No. 2.—The resulting mass dissolves completely in cold water, and by boiling the solution, the titanlic acid can be precipitated.

Chromic iron ore is decomposed very easily. In one case in which I timed the operation, the fusion was complete in less than three minutes from the time I began to heat, and that over an ordinary Bunsen's gas burner. The cooled mass is light green, partly soluble in water alone, and entirely soluble in hydrochloric acid.

Fusion No. 2.—The mass possesses a deeper green colour than that obtained by the first fusion, and a larger proportion of it dissolves in water. In every fusion that I have yet made of chromite, however, a small quantity of basic salts was formed, requiring treatment with hydrochloric acid.

Emery is rapidly and easily resolved. The mass contains basic compounds that require hydrochloric acid for complete solution; although water dissolves a large proportion of it.

Fusion No. 2.—The mass thus obtained is entirely soluble in water.

Hematite.—(An exceedingly hard specular ore from

the Tilden mine, Lake Superior). It was completely resolved, giving a mass partially soluble in water, but dissolving entirely in hydrochloric acid.

Fusion No. 2.—The mass dissolves completely in water.

Limonite and **magnetite** behave exactly like hematite.

Zircon is entirely decomposed. All its silica is converted into the gaseous fluoride of silicon, and driven off. The mass obtained resembled that given by rutile. It dissolved almost entirely in cold water, but the solution speedily became turbid and deposited a white precipitate, which was either zirconia or some basic salt of that oxide. By first digesting the mass with a little strong hydrochloric acid and afterward adding water, the whole went into solution.

Fusion No. 2, afforded a mass of a beautiful waxy lustre, which was completely soluble in water.

Kyanite is entirely resolved, and, like zircon, freed from silica. The white mass contained basic compounds, and consequently required hydrochloric acid for complete solution. A second fusion gave a mass entirely soluble in water.

Orthite is completely decomposed, and deprived of silica. The mass was white, and dissolved partly in water. The insoluble residue contained basic salts and some sulphate of lime, and hydrochloric acid dissolved all but the latter.

Fusion No. 2.—With the exception of a little sulphate of lime, the mass dissolved in water.

Quartz sand.—I subjected some of this substance to fusion with the mixture of bisulphate of potash and fluoride of sodium, in order to ascertain to what extent silica would be converted into fluoride of silicon. The fusion took place very easily, giving a white mass which dissolved almost entirely in water. Only a very small trace of insoluble residue remained, probably not more than one-tenth of one per cent. of the quantity of sand taken. It is very probable that more careful treatment would get rid of even that small amount. After this it seems impossible to doubt that any and all silicates would be decomposed and freed from silica by this process. A convenient method is thus afforded for the estimation of bases in silicates, bearing in mind, however, that a second fusion with sulphuric acid will in most cases be necessary.

As far as concerns the complete resolution of any mineral, pure, finely pulverised cryolite may be substituted for fluoride of sodium. It labours under the disadvantages, however, of introducing alumina into the mass obtained, but nevertheless it can be advantageously employed in cases where the introduction of alumina is a matter of indifference, as in the technical analysis of tinstone and chromite, and the estimation of iron in ores, slags, and cinders. The perfectly white translucent specimens of cryolite should be chosen for this purpose.

Either the bisulphate of potash or of soda may be used, and although neither seems to possess any advantage in point of thoroughness, the potassa salt appears to be the most readily fusible, and is therefore to be preferred.

The following are the advantages that I claim for this process:

First. Speed. Among the different minerals upon which I have tested the action of this mixture, I have found no case where I was obliged to heat longer than five minutes, and many fusions are complete in three, and even less.

When bisulphate of potash alone is used for a similar

purpose, it is usually necessary to heat for from half to three-quarters of an hour; and even then in the cases of emery, chromite, and some other minerals, it is almost impossible to obtain absolutely complete resolution.

By my process, even when the second fusion with sulphuric acid is necessary, not more than twenty minutes should be consumed in both fusions and the time for cooling between them.

Second. In every case except tinstone that has come under my observation, in my process, an ordinary Bunsen's burner may be used as the source of heat; whereas, by most other methods, a blast lamp is necessary.

Third. When bisulphate of potash *alone* is used for the decomposition of chromite, &c., it is necessary that the mineral should be reduced to extremely fine powder; but, when the mixture of bisulphate and fluoride is employed, although the mineral should be in fine powder, such an extreme state of subdivision is by no means required, and thus much labour is saved.

Fourth. In all cases when this mixture is used, the resolution of the mineral is absolutely perfect. Furthermore, all the silica is got rid of at once, and all the bases present are converted into sulphates. This last is a great advantage whenever iron is to be determined volumetrically by means of hypermanganate of potassa solution. As far as thoroughness of action is concerned, or generality of application, I can claim no advantage for my process over the use of acid fluoride of potassium; but the last-named reagent is difficult to prepare, and when prepared, cannot be preserved in glass vessels.

Fluoride of sodium is subject to neither of these disadvantages, and in the mixture with bisulphate of potassa, has slight advantages as regards rapidity of action.

It may not be out of place for me to mention here a fact connected with the use of fluoride of ammonium for decomposing silicates, as described by Rose. After fusing the mineral with the fluoride, he directs treatment with sulphuric acid, for the purpose of converting the bases into sulphates. I find that if, in the first place, sulphate of ammonia is mixed in excess with the fluoride, all the bases are directly converted into sulphates, thereby obviating the necessity of treatment with sulphuric acid.

Technical Determination of Chromium in Chromite.—After fusion with cryolite and bisulphate of potash, as previously directed, the mass is to be treated with a little strong hydrochloric acid, and allowed to digest for about ten minutes. Then, upon boiling with water, the whole dissolves. The solution should then be neutralised, acetate of soda added, and the chromium oxidised to chromic acid by a current of chlorine gas, or by boiling with hypochlorite of soda solution. The chromium may then be separated from other substances, as directed in Professor Gibbs's paper, (*Am. Journ. Sci.*, January, 1865). When chromite is fused with bisulphate of potash and cryolite, and saltpetre is added to the mass, as soon as clear fusion is obtained, the chromium is nearly all oxidised to chromic acid. If the mass be boiled with a solution of carbonate of soda, and the liquid filtered, a filtrate is obtained which contains nearly all, but not quite all the chromium as alkaline chromates, free from iron or alumina; but, invariably, the residue upon the filter contains traces of chromium. When chromite is fused with the acid fluoride of potassium, a part of the chromium is usually oxidised to chromic acid by the oxygen of the air; and in one case that came under my observa-

tion, when I came to heat the resulting mass with sulphuric acid, red fumes were given off, which were probably the so-called terfluoride of chromium.

Technical Estimation of Iron in Ores, Slags, and Cinders.—After fusion with cryolite and bisulphate of potash, the mode of treatment varies according to the method it is desired to use for determination of the iron. If Penny's process of estimating iron volumetrically with bichromate of potassa, or the ordinary method of precipitation with ammonia, is to be employed, the mass may be treated with hydrochloric acid, and thus brought immediately into solution. If, on the contrary, the iron is to be determined volumetrically by means of hypermanganate of potassa, the use of hydrochloric acid is interdicted, and it becomes necessary to fuse again with sulphuric acid and dissolve in water. When volumetric processes are used, the whole determination of the iron, from the time the assay is placed in the crucible, should take less than an hour to perform.

This process has a great advantage over all others, in the examination of ores, slags, and cinders containing iron, both as regards speed and convenience. A perfectly clear solution is immediately obtained without filtering, all the silica is got rid of, and it is only necessary to reduce the iron with hydrogen, and then to titrate. If in an iron ore it is desired to determine also titanic acid and manganese, it is best to make the subsequent fusion with sulphuric acid. The clear solution obtained is diluted to a known quantity, and by means of a graduated pipette divided into several portions. In one part the iron may be reduced and determined volumetrically; in another, the titanic acid thrown down by boiling. In still another portion, the iron, alumina, and titanic acid may be thrown down by boiling with acetate of soda, and in the filtrate, the manganese may be precipitated by a current of chlorine gas, or by boiling with hypochlorite of soda. If fluoride of sodium be used instead of cryolite in the fusion, lime and magnesia also may be estimated. For determining silica, phosphorus, and sulphur, other methods must be employed.

Preparation of Fluoride of Sodium.—When pure finely pulverised cryolite is boiled with caustic soda solution, it is, as is well known, decomposed. Fluoride of sodium is deposited as a jelly-like mass at the bottom of the vessel, and the supernatant liquid contains aluminate of soda, a little fluoride of sodium, and the excess of soda. The deposit of fluoride is to be washed with cold water until the washings have no longer an alkaline reaction; and is then purified by repeated solution and evaporation. It is so difficultly soluble, and crystallises so badly, that this last is a matter of some difficulty; but the first part of the process is so very easy that the crude fluoride of sodium can be prepared by the hundred-weight without much trouble. Iron vessels are suitable for the operation, but must be very clean and free from rust. If caustic potassa be substituted for soda, the deposit of fluoride of sodium is smaller, and the supernatant solution contains aluminate of potassa, fluoride of potassium, and a little fluoride of sodium.

Possibly the fluoride of potassium might be prepared in a state of purity from this solution, but it is extremely problematical whether this could be done economically. When pure cryolite is fused with carbonate of soda, and the used mass powdered and treated with water, fluoride of sodium is dissolved out. This method, however, cannot compare with the first for convenience and economy.

It may not be altogether out of place to remark in

this connection, that I find that when fluoride of sodium is heated with sulphate of ammonia, fluoride of ammonium is formed and sublimes. Possibly this may be turned to advantage, although I have made no experiments upon obtaining fluoride of ammonium in quantity by this process.

Before closing this paper, I also wish to state that I made numerous experiments with a view toward applying the mixture of fluoride of sodium and bisulphate of potash to the estimation of both oxides of iron when they occur in minerals; but I met with no success.

During the course of the experiments described in this paper, I have been largely indebted to Dr. Wolcott Gibbs for many very valuable suggestions and much excellent advice which aided me exceedingly.—*American Journal of Science*, xlv., 173, March, 1868.

CHEMICAL RESEARCHES ON SUGAR REFINING.

BY M. EMILE MONNIER.

If sulphurous acid gas is conducted into a chamber containing coarse sugar, the latter is promptly bleached, and about three-fourths of the colouring matter are entirely destroyed, whilst the sugar undergoes no change whatever in composition. After this treatment the sugar smells strongly of sulphurous acid, which presents no inconvenience in the process of refining. To bleach sugar in this manner, for 1,000 parts by weight of sugar about four parts of sulphur must be burnt, and the gas conducted into the chamber. When the operation is once set going, the proportion of sulphur may be notably diminished. The sulphur is converted into gas by combustion in a little furnace placed at the side of the chamber. When the action is complete, the sugar is dissolved in water, and its sulphurous acid neutralised by a small quantity of lime. This lime may be previously converted into sucrate of lime by M. Peligot's method, that is, by crushing it with a little syrup; for 1,000 lbs. of sugar three or four lbs. of lime are requisite in the form of sucrate.

M. Monnier has been at great trouble to ascertain whether the sulphurous acid gas thus used modified the sugar so as to produce a certain amount of grape or non-crystallisable sugar, and he has convinced himself that sugar bleached in this manner undergoes no change whatever. The quantity of non-crystallisable sugar found by analysis after the operation in question was, in each case, exactly equal to the amount which the sugar contained before being bleached; namely, on the average, about 2.15 per cent. In all these experiments the sugar was exposed about forty-eight hours to the bleaching action.

The above process gives most striking results with exotic sugars, which are highly coloured; with lighter coloured samples, the bleaching is not so marked; but in the former case, two-thirds to three-fourths of the heterogeneous colouring matters are eliminated completely.

ON SCIENCE TEACHING IN SCHOOLS.

BY OSCAR BROWNING, M.A.

As the subject of the teaching of science in schools is being discussed in these columns, it may perhaps conduce to the settlement of the question if I offer a few suggestions from a practical point of view.

It will be scarcely necessary to consider the position of those who think that science should be made the basis of education. It is possible that the training of the future may take this form, which is so ably advocated by Mr. Herbert Spencer; the attempt which is being made in France to create an "enseignement secondaire special," of which the backbone is mathematics, and in which science takes precedence of literature, may offer a lesson or a warning to coming generations. But in our time the supremacy of literature is not likely to be overthrown, partly because it is probably the best training for the majority, partly because it has in its favor the prescriptions of many years, but chiefly because adequate teachers of science cannot be found. The new scheme of education in France, to which I have above referred, cannot be put into action until the Normal Schools of Cluny and Mont Masan have sent forth several generations of professors. The problem which we have to solve is, after admitting that science is ancillary and subordinate to literature in education,—to decide what science is to be taught and what means are to be used in teaching it.

There is at present great want of a recognised programme of scientific study. In founding scholarships for natural science there appears to be a great difficulty in arranging the limits and scope of the examination. The witnesses examined on this subject before the Public Schools Commission do not agree; each one asserts that his own subject is admirably fitted to be an educational instrument, but he does not attempt to define the place it should hold in a general scientific education, or the relations which it bears to its competitors. The only subject which several scientific men agree in recommending is applied mathematics. They urge the study of mechanics and hydrostatics at schools. There is scarcely a school in England where mathematics are not taught to every scholar, and there are, I should imagine, few minds which are incapable of apprehending mathematical reasoning. At Eton it is frequently found that the best classics are also the best mathematicians. There can be no reason why applied mathematics should be more difficult of apprehension than the pure science, and it would seem advisable to introduce the teaching of statics, dynamics, and hydrostatics, into all schools, treating the subjects both mathematically and experimentally, so that they may form a link between the two branches of science, and there can be no reason why these subjects should not be obligatory upon all the scholars.

After this we leave our certain ground, and are obliged to feel our way with greater caution. Various authorities have recommended the teaching at schools of botany, geology, physiology, natural history, physics (*i. e.*, heat, electricity, magnetism, &c.), and chemistry. It is obvious that if science in the whole mass is to be subordinate to literature, and if pure and applied mathematics are to be taught compulsorily to all, that the whole range of these subjects cannot be made part of the regular school course, unless they are to be taught with an unreal and delusive shallowness. We must make a selection, and the only safe principle appears to be that each of these studies is suited to a different mind, and that Nature herself indicates which is the most proper to be taught to each individual.

We cannot speak with any certainty of the process of growth in the human mind. But by careful watching we seem to arrive at the conclusion that the faculties of each mind are evolved in an order peculiar to that individual. There is nothing more capricious or inex-

pliable than the steps by which the full manly growth is arrived at from the size of childhood. If you take twenty boys at eleven years old, with some knowledge of their parentage, you may predict what development they will have reached at twenty-five. But you cannot indicate the steps by which this development is to be attained, or the age at which the most critical change will occur. It would seem to be the same with the mind. Experience of boys' minds tends to show me that they are not generally indolent or inactive; that if they are surrounded by healthy conditions, they are really desirous of growth and nourishment. The chief difficulty of the teacher is to discover the precise food which is required at a given time. If this is offered it is received and assimilated with the greatest ease and rapidity. The most perfect possible education would be given by supplying at the right moment the intellectual food for which the healthy mind was craving. The most astonishing results in education have been produced where very able men have given their whole thoughts to the education of very able boys. This is impossible at a public school; there must be a fixed curriculum of some kind, and this we have decided is to be literature and mathematics. But the various branches of science I have above enumerated are admirably suited to be applied as alternatives to the jaded mind, and to excite the appetite for knowledge which may have been dulled by application to the regular studies.

Sciences which possess a complex terminology are often acquired with ease by very young children. A boy whose tastes lie in that direction will learn the names of a great number of flowers and insects before he is ten years old, and in cases where this appetite for accumulating names is not directed to a useful subject it has recourse to heraldry or stamp collecting, or some similar pursuit. The existence of this power in childhood may not indicate any faculty of grasping scientific truth in the mature man, but it stores the mind with facts which would be learnt far more laboriously at an advanced age. It frequently happens that a dull sluggish scholar has his mind assailable by some particular branch of science. I may mention some cases of this which have come under my notice. It would be well if schoolmasters could adopt the plan of describing their cases of education as methodically and accurately as a doctor describes his cure. In this way a mass of information might be collected which would be of the greatest service in forming a true theory of education.

A., aged 14, stupid in classics and mathematics, fond of chemistry experiments, and of mechanical contrivances. Attended a course of lectures with "Roscoe" as a text-book; answered questions on the first twelve chapters of "Roscoe"; read "Hofmann's Chemistry" with a competent teacher; begged to be allowed a chemical tutor in the holidays, and worked with him through "Conington's Analysis"; if he works well, will be fit for a foreign university in a year's time; his general intelligence has wonderfully brightened, and his love of work increased.

B., aged 14, clever in classics, fair in mathematics, generally cultivated in language and history. Studies chemistry in "Roscoe" and "Hofmann"; gives most of his time to geology in "Lyell" and "Jukes," which he knows thoroughly; is well acquainted with the geology of Scotland and the Isle of Wight; spends his leisure time in arranging fossils; read "Darwin's Cruise of the Beagle" twice, and the "Origin of Species" with avidity and intelligence.

C., aged 13, very fair in classics and mathematics;
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has read a great number of books on entomology, which is his special study; knows "Kirby and Spence" almost by heart.

D., aged 16, very dull in the regular work; has written a good and exhaustive book on the birds of two English counties; is devoted to ornithology.

These cases are drawn from a small area, and are perfectly well known to me. In each case the study of their particular science has made them more generally bright and intelligent, but they do not show any desire to learn the sciences which lie outside the circle to which they have devoted themselves.

Now, science may be taught in three ways—1st, as a collection of facts useful to be known; 2nd, as a training of the observing and reasoning powers; and 3rd, as a means of educating those who are destined to be workers in that particular field. The first of these is not to be despised. A knowledge of leading physical facts should be a part of all education; it may help to guard against mis-conceptions where it does not give actual knowledge. It is best imparted by lectures; and I should believe that one or two lectures given by the very best informed men in the several subjects, would be more effectual than many lectures given by men of inferior brilliancy. A system of itinerant lectures to great schools by great men would be a powerful educational engine. Besides, it is only by these lectures that the special aptitude can be discovered or called into existence. The sight and voice of great discoverers may fertilize latent germs of kindred genius.

The second aspect of scientific study has been dwelt upon with force and eloquence by Mr. Wilson on several occasions. He has shown how the study of science may train the mind in that which ought to be the end of all teaching, accuracy of thought and accuracy of expression. But nearly all sciences will do this equally as well, and many branches of a literal and mathematical training will do it also, and no branch of science is likely to do it effectually unless the interest and attention of the learner be first excited. It is quite true that the pursuit of truth is at present a characteristic of science, but it should also be a characteristic of theology and morals, philology, and history. Teaching has by the indolence and bigotry of mankind degenerated in many cases into the mere enouncing of ready-made conclusions, which are to be accepted without question by the hearer. Science still dwells upon the heights and breathes the pure air of divine philosophy. But is there no trace of such attachment to ascertained truths in the history of science itself? Were not the discoveries of Fresnel suppressed by older savants who feared their revolutionary character, and does not M. Duruy suspend the professor of physiology whose conclusion leads him to the conclusions of materialism? The introduction of science into schools may serve to emancipate our existing teaching of other subjects; but it may also find that it has entered into the house of bondage, and in any case it is not the only study which is fitted to brace and exercise the mind for the search after pure and simple truth. The calculus of reasoning which science imparts is analogous to that of mathematics, philology, logic, or metaphysics. But I question myself if it is not a coarser and less powerful engine of thought than that by which a sheet of Thucydides is translated, or a passage of the Choephore restored. The third end of scientific teaching is all-important. It is of the utmost moment to the country that no special talent should be lost to it. Our little army of explorers, in all branches of art, science, and

literature, is not so large that it can dispense with recruits, while the adaptation of the outward circumstances of existence to the requirements of the development of the inner nature is the only means of assuring an harmonising and happy life. Every boy who is capable of receiving an education by means of any branch of physical science should have the fullest opportunity and encouragement to do so. I think I have by this time indicated the precise action which I would advocate.

1. That no exact study of science should be compulsory except that which is closely connected with mathematics.

2. That lectures should be given on all branches of science by distinguished men, for the purpose of giving useful information, and stimulating the zeal of those who are likely to devote themselves to any branch of the subject.

3. That accurate teaching in chemistry, botany, geology, natural history, and the various branches of physics not included in applied mathematics, should be provided to all who show a special aptitude and desire for the study, and that such boys should be excused so much of the school curriculum as would enable them to study the subject with profit and advantage.

I must now conclude this very hasty sketch of the kind of science teaching which I think should be provided in schools. The greatest danger which we are running in England in the matter of education is of adopting a too extended curriculum which must necessarily be shallow. They are discovering in France, Germany, and Holland, that they have made this mistake. But in these countries everything is regulated by a ministerial programme, and the only method of consulting special aptitudes is by introducing a system of bifurcation, which answers as badly abroad as it does in England. But in our great English public schools, the freedom from control among the boys, and the close and affectionate relation between the tutor and the pupil, gives scope to a liberty of learning and a liberty of teaching, which we are told is the informing spirit of the German universities. To these two great principles we ought to cling. The advocates of new studies only succeed in proving that they are good engines of education. They do not convince us that we should abandon the old studies or force the new upon all. De Tocqueville left us a warning that we should not become *polytechnise's*, as Frenchmen are. The real advance in education lies in the reverent and loving watching of each human soul, the guarding it from all influences which may confine or distort its growth, and the surrounding it with all the food it asks for the support of its daily life, that by the gradual progress of individual development it may arrive at a mature character which will find the world in which it lives in accord and harmony with its aims and aspirations. If this training were adopted by us, a public school would present a rich variety of character which philosophers think that our modern society is certain soon to lose. And in obtaining this diversity, science has to play a very important if not the chief or leading part.

Eton, May, 1868.

ON THE ESTIMATION OF POTASH.

BY F. T. TESCHEMACHER & J. DENHAM SMITH.

IN the CHEMICAL NEWS of the 24th ult., No. 438 (*Amer. Repr. June, 1868, p. 284*), we read, well nigh with

dismay, an abstract of a memoir on "*The Estimation of Potash*," by Messrs. James Chalmers and R. R. Tatlock.

For years we had pinned our faith on the truth of the results indicated by the chloride of platinum and potassium; so clean, so exact, and so unvarying were they, with the added and vast advantage that an error in the platinum salt, unless gross indeed, affected the outcome of potash but slightly; and now we are told that this faith is naught, and that we have been blundering all our days.

May we be permitted to make some cursory remarks on the memoir in question, with the view of showing wherein we agree or differ from these chemists, of describing a process, in detail, which will yield exact results, and of the issues of some few experiments, made with the object of reassuring ourselves, after the rude shock our belief in the platinum salt had sustained, and thus defending the true faith in this matter.

We are told that "Glasgow is the destination of almost all the muriate of potash manufactured from the interesting deposit in the vicinity of Stassfurt," &c.: a statement which, if true, would be much to the advantage of Glasgow and its chemists; but, in our present sceptical state of mind, we are curious as to the source of the saltpetre used in France, Germany, and Central Europe, if Glasgow monopolises the Stassfurt muriate; and also how it happens that both France and Germany nowadays export refined saltpetre to this country; a manufacture, especially the German nitrate, of singular excellence, often containing less than one ounce of impurity to the ton of refined saltpetre.

Our authors, on the plea that "they have made thousands of potash determinations, urge that they may fairly claim to have some acquaintance with the subject;" a claim to have been admitted, had these potash determinations been correct; but as the very gist of this memoir is that all potash estimations, necessarily including these thousands of their own, have been wrong, or at the best doubtful, such acquaintance, that of erroneous practice, must needs be worse than none at all. Several remarks now follow to show that "the general tendency is to report potash too high;" that they have found "results giving a total of 100 per cent in a muriate of potash, from potassic chloride and water alone." We presume this sentence means, that the authors have seen a certificate of an analysis of a sample of muriate of potash, setting forth that water and chloride of potassium were its sole constituents, and consequently "they feel warranted in saying that serious errors were made," a statement in which we heartily agree. "They admit that such remarks may seem to involve rather strong and severe strictures on experienced analysts;" and here again we are at one with them, only we should omit the qualifying words with which they dilute their judgment, and limit our adherence to its justice, by assuming that these remarks relate to the chemists of Glasgow only; subject to which proviso we cordially concur in all they have said in this division of their memoir, as it exactly tallies with our own experience of Glasgow estimations of potash salts.

Here we fear that our agreement with the authors of this memoir ceases for a while, for we deny, *in toto*, that the errors in question "are chiefly due to an unsuspected source of error in the reagent employed," maintaining that these errors, which, beyond question, are of constant occurrence, are due to imperfect manipulation, and to this alone. We must also deny that "the purity of the platonic chloride solution, the key-stone

of their process, is requisite to ensure accuracy," and as we are not by any means certain that "crime and punishment are inseparably associated," we also are latitudinarian enough to assert that "impure platinum," at least that which our authors regard as such, "and false results," have no necessary connection, and that true and accurate results depend solely on manipulation.

We presume that these gentlemen, and Glasgow chemists generally, obtain the double salt of platinum and potassium as the bright yellow powder, the characteristic test for potash (if so, here is one source of error); we have long since found it difficult to obtain reliable results from this salt in the pulverulent condition, and possibly also they have been sparing in their platinum, another fatal error; but on these points we are left in the dark, so far as the abstract in your Journal can inform us. We gladly note the excellence and value of most of the points in manipulation described under "II," p. 200, as part of a system we hold to be indispensable to accuracy. This brings us to our second object, that of describing in detail a process for estimating potash which will yield exact results; and here, Sir, we fear that we must trespass on your space, and possibly on the patience of your readers, as we fully share the objection these Glasgow gentlemen raise to the meagre nature of the details of analytical processes furnished in many books on chemical analysis, far preferring the extended and exhaustive descriptions of H. Rose, to the concise and bald methods, interrupted by continual references, adopted by his successors.

We assume the salt under examination to be a sample of commercial muriate of potash, or that the alkalies exist in such a condition that by the addition of hydrochloric acid in excess, they will be converted into chlorides. Like Messrs. Chalmers and Tatlock, we also take 500 grains of the salt, previously carefully ground and mixed, and dissolve it in water, filtering if requisite, and washing the insoluble portion till solution and washings measure 5000 grains. Mix this solution by pouring from one glass to another, and take 500 measured grains of this solution (we must lay stress on accurate measurement, always at one level of the eye and one level of liquid and line of measurement), and dilute these 500 grains till they measure 5000 liquid grains, and mix: 1000 measured grains of this solution contain 10 grains of the original salt.

Now, to 1000 measured grains of this solution, add excess, say 50 grains of hydrochloric acid if the alkalies are not present as chlorides, and pour into a shallow porcelain dish, making with the rinsings of the measure, &c., some 1500 grains of solution. Heat the dish and contents nearly to ebullition, and add to the hot solution so much solution of chloride of platinum as is equal to 20 grains of the metal. Evaporate this mixture on water-bath nearly to dryness; that is to the point when the thick syrupy liquid, on the momentary removal of the dish from the bath, passes into an orange-coloured pasty mass. At this point remove the dish from the bath, and at the same instant and before the dish and its contents have had time to cool, drench it with, say 500 to 600 grains, of rectified methylated spirit containing about 15 per cent of water to 85 of the alcohols; mix rapidly by imparting a rotary motion to the contents of the dish; then cover it and allow it to digest for, say 5 minutes. Have not too small a filter ready—of some 400 to 500 grains capacity—in a funnel with a cover, it will facilitate filtration by washing the filter first with hot water and then

with spirit, after this short digestion pour the alcoholic solution of the platinum salts on to the filter, draining the crystalline solid scales of the potassium salt as dry as possible, and again drench, agitate, and digest the insoluble salt with spirit; repeat this a third time, when the spirit will come away nearly colourless. Now collect the light orange crystalline scales of the chloride of platinum and potassium on the filter, by means of a wash-bottle, and, if need be, wash with spirit till it passes perfectly colourless. It is very advisable to wash the platino-potassic chloride by decantation, and finally by a stream of spirit from a wash-bottle, to avoid the use of stirrers so as to prevent the scales being broken down, and to keep both dish and funnel lightly covered till the washing is completed.

There is now nothing more to be done than to dry and weigh the platino-potassic salt, and to ignite and weigh the filter and add this to the weight of the salt. Owing, however, to the crystalline nature of the salt thus obtained, but a slight stain adheres to the filter, so that the loss by ignition is infinitesimal and does not affect the result. As this crystalline precipitate is not hygrometric, its weight is easily and accurately determined.

We trust that this description of the process, which we have purposely made exhaustive in its details, admits of easy comprehension by those readers who may be interested in the subject, and especially by the authors whose memoir has induced us to bring this process to your notice; but for the sake of clearness we beg permission to recapitulate its leading and important points:—

I. Dilution of solutions.

II. Use of chloride of platinum in large excess, about 20 grains of metallic platinum to 10 grains of salt examined.

III. Heating of solutions, and evaporation so conducted as to obtain the potassic salt in a crystalline scale-like condition.

IV. Evaporation on water-bath to a pasty condition—no further.

V. Drenching with spirit whilst salt and dish are hot, and instantly on removal from water-bath.

VI. Washing by decantation, and avoiding breaking down of the crystalline precipitate.

In practice, the process is a rapid one, from beginning to end requiring about two hours' less time, indeed, than was frequently expended in merely washing the dense pulverulent precipitate we denounce as liable to many sources of error.

We have little more to add besides the results of the experiments we made to reassure ourselves of the thorough trustworthiness of this mode of estimating potash.

No. I. The pure German saltpetre before referred to, yielded by the foregoing process, from 1000 measured grains of solution = 10 grs. of salt, 24.20 grs. of the double salt of platinum and potassium = 10.009 of nitrate of potash, being an error, in excess, of 1.3500th of the potassium present.

No. II. 400 grs. of the same saltpetre, 100 grs. of common salt, and 6 grs. of sulphate of magnesia were dissolved in the requisite quantity of water, an imitation of an ordinary sample of the Stassfurther muriate of potash, *quoad* the potash; two separate portions of 1000 measured grains acidified with hydrochloric acid, = 8 grs. of the potash salt, yielded respectively 19.20 and 19.30 grs. of the platinum salt = 7.941 and 7.982.

of the potash salt, showing in both cases a loss of 0.059 and 0.018 respectively, instead of a gain, the mean loss in potassium being 0.0148, a result, we venture to submit, close enough for any purpose.

It so happens that our chloride of platinum is the produce of years, and from repeated use of the metal over and over again it is probably pure, or nearly so, by this time; we therefore procured some spongy platinum from Messrs. Johnson and Matthey, the source of platinum which, in Messrs. Chalmers' and Tatlock's hands yielded results they characterise as an "alarming state of things, showing that ordinary spongy platinum is not in a fit state for procuring pure platonic chloride."

We dissolved this spongy platinum just as it came from the makers, without any attempt at preliminary purification, and as this solution, when of equal strength to ours, was somewhat darker and redder, it probably was not quite so pure.

This solution with 1000 grs. of No. 1 = 10 grs. of nitrate potash, duly acidified with hydrochloric acid, yielded 24.10 grs. of the platinum salt = 9.860 of nitrate of potash, being a loss instead of a gain, and the worst result of our tests; whilst 1000 grs. of No. 2 solution = 8 grs. of potash salt, yielded with this "impure" solution of platinum 19.35 grs. of platinum salt = 8.003 of potash salt, a result which should satisfy the most exacting chemist.

None of these tests were made with any special care, but were treated in the usual way we adopt and have already described for estimating potash. We must add that we take 244.20 as the equivalent of the double chloride of platinum and potassium, which we think is that of the authors of the memoir.

In conclusion, we venture to submit to the judgment of yourself and the readers of your Journal, that we have proved that the estimation of potash by means of platinum may be implicitly relied on as yielding most accurate results, provided a proper and uniform mode of manipulation be adopted; and also, that the absolute purity of the platinum solution is a non-essential, that made from the usual spongy platinum of commerce answering the purpose as well as the purest.

RESEARCHES ON DI-METHYL.*

BY W. H. DARLING,

DALTON SCHOLAR IN THE LABORATORY OF OWENS COLLEGE.

THE synthesis of carbon compounds forms perhaps the most important and interesting branch of modern chemical enquiry. The most recent developments of these synthetical processes are the now well ascertained facts of the dependence of the chemical properties of the molecule upon the position of the individual atoms of which that molecule is built up.

Any isomeric modifications of the saturated monovalent compounds containing one or two atoms of carbon can only be explained by the existence of a difference between the four combining powers of each carbon atom, whilst in the tri-carbon and higher series isomerism indicates the difference in the power of combination existing between the end and the middle carbon atoms of the chain.

From Frankland's original observations concerning

the difference between the action of chlorine on the so-called di-methyl—



obtained by the electrolysis of an alkaline acetate, and on the hydride of ethyl—



obtained from ethyl compounds, the existence of a difference in the four combining powers of a carbon atom was rendered probable.

The subsequent researches of Schorlemmer have, however, proved that only one hydrocarbon of the formula C_2H_6 exists, inasmuch as he succeeded in preparing ethyl chloride from the hydrocarbon di-methyl—



obtained by the electrolytic decomposition of an alkaline acetate (*Proc. R. Soc. xiii.*, 225); as well as from ethyl hydride, obtained from ethyl compounds.—(*J. Chem. Soc. N. S.*, ii. 262.)

It appeared of great interest to repeat this synthesis, and to prepare the chloride in larger quantity, from which to prepare ethyl compounds and ascertain their chemical and physical properties.

At the request of Mr. Schorlemmer, I undertook this investigation. I take this opportunity to express my thanks to that gentleman, and also to Professor Roscoe for the kind assistance rendered to me throughout this research.

I prepared the di-methyl by the electrolytic decomposition of acetate of potash, according to the process described by Kolbe. The gas, evolved from a platinum plate contained in a porous cell, was passed first through a solution of caustic potash, to absorb the carbonic acid, afterwards through nordhausen acid, and over pumice-stone moistened with oil of vitriol, to free it from a trace of oxide of methyl or hydrocarbon absorbable by this acid, and finally through a solution of caustic potash, to absorb acid fumes, any carbonic acid which had escaped the first wash-bottle, or traces of sulphurous acid. The gas thus prepared had a very slight odour, it burnt with a non-luminous flame.

The following analysis of it is according to Bunsen's method:—

	Volume.	Pressure.	Temp. C.	Volume at 0° C. and 760 mm. Pressure.
(1.) Original volume of Gas	183.48	0.1402	8.5	24.94
(2.) After addition of Oxygen	333.41	0.3919	8.0	127.00
(3.) " " air	567.52	0.5221	8.5	287.5
(4.) " explosion	595.38	0.4591	9.2	224.7
(5.) " absorption of carbonic acid (dry)	447.58	0.4156	12.3	173.9
Contraction observed.....	.....	.....	.....	62.35
Carbonic acid ".....	.....	.....	.....	49.83
Hydrogen in two volumes of gas found 6.076.....	.....	.....	.....	6.000
Carbon ".....	.....	2.036.....	.....	2.000

This gas, treated with an equal volume of chlorine, was exposed to the diffused sunlight, after allowing time for the two gases to mix until nearly colourless, and completed by means of direct sunlight when quite colourless. The bottle was opened under warm water; the hydrochloric acid was absorbed equal to half the capacity of the bottle. The remainder of the gaseous contents not absorbed were displaced by warm water into a receiver, in which a few pieces of stick potash were placed, surrounded by a freezing mixture of salt and ice—a colourless, volatile liquid was con-

* Communicated to the Man. Lit. and Phil. Soc. by Professor H. E. Roscoe, Ph.D., F.R.S.

densed.* One hundred grammes of chloride were prepared by the repetition of this process. This first product was separated by distillation into two parts, one which distilled below 30° C., and the other above 30° C. On still further fractionating the first distillate, a portion was obtained boiling at 11–13° C., whose sp. gr. was 0.9253 at 0° C. Pierre found the specific gravity of ethyl chloride to be 0.9241 at the same temperature.

The chloride boiling below 30° C. gave on heating in sealed tubes with acetate of potash and glacial acetic acid to a temperature of 130°–140° C. for three or four hours, a volatile fragrant liquid, having the characteristic odour of acetic ether, which after drying over chloride of calcium and magnesia, boiled at 74.00–75.5° C. Kopp gives the boiling point of ethyl acetate at 74.3 under a pressure of 760 mm. of mercury.

In order to prepare the alcohol, the acetate was heated with crystals of baryta hydrate in sealed tubes for one or two hours, to a temperature of 120° C.; after cooling it was distilled, and the distillate treated with dry carbonate of potash until it separated into two layers, the upper one was decanted upon fused carbonate, afterwards upon anhydrous baryta, from which it was distilled, when it had assumed a light amber colour. It began to boil at 78.1°, the whole coming over before the temperature exceeded 79.0° C. Kopp gives the boiling point of ethyl alcohol prepared by fermentation at 78.4° C. under a pressure of 760 mm. mercury, and the specific gravity at 0° C. as 0.8095; calculating by means of his coefficient of expansion the sp. gr. at 6° C. would be 0.80446, whilst I found the same to be 0.80302 at the same temperature.

The alcohol thus prepared had very little odour, agreeing in this respect with the observation of Meudelejeff (*Zeitschrift Chemie*, 1865, 257), though the specific gravity is slightly higher than his at the same temperature calculated from his coefficient of expansion, viz. 0.80123.

On submitting this liquid to combustion analysis the following numbers were obtained.

No. 1. 0.2834 grm. of liquid gave 0.5357 grm. of carbonic acid, and 0.3314 grm. of water.

No. 2. 0.5533 grm. of liquid gave 1.0481 grm. of carbonic acid, and 0.6480 grm. of water.

	Percentage No. 1.	No. 2.	Calculated from the formula C ₂ H ₆ O.
C	51.56	51.65	52.17
H	12.99	13.02	13.04
O	35.45	35.33	34.00
	100.00	100.00	100.00

The numbers are not all that could be desired when compared with the calculated, this is owing to the difficulty in burning so volatile a liquid, and to the small quantities taken. Dumas and Boullay (*Ann. de Chimie*, 1827, 36, 299) state that in order to obtain agreeing results upwards of a grm. of liquid was necessary, in one combustion 1.742 grms. were used; with ether a still greater quantity was required.

* If the gas or the chlorine was not pure, being mixed with air, very little or no liquid was condensed, being carried off by the current. The same was observed by Mr. Schorlemmer. This will probably account for Frankland's observation that no liquid was condensed at -13° C.

The alcohol still remaining in the carbonate of potash, and in the dilute solution was separated by distillation, this distillate was oxidised by a mixture of bichromate of potash and sulphuric acid, when the characteristic odour of aldehyde was recognised, the oxidation was continued until it had disappeared, on distilling to dryness an acid distillate was obtained, this was neutralised with pure carbonate of soda, and yielded on evaporation needle-shaped crystals of acetate of soda; the mother liquor was distilled to dryness with sulphuric acid, the distillate neutralised with pure carbonate of silver, filtered and boiled, on cooling it yielded colourless transparent flat needles, which, after drying over sulphuric acid, gave on analysis the following numbers.

No. 1. 0.4142 grm. of salt gave 0.2663 grm. of metallic silver.

No. 2. 0.5095 grm. of salt gave 0.3274 grm. of metallic silver.

No. 3. 0.3650 grm. of salt gave, after drying at 100° C. in a water bath for one hour, 0.2349 grm. of metallic silver.

No. 4. 0.2483 grm. of salt gave, after drying at 100° C. in a water bath for two days, 0.1604 grm. of metallic silver.

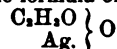
Estimation No. 1 gave 64.30 per cent of silver.

" No. 2 " 64.25 "

" No. 3 " 64.36 "

" No. 4 " 64.60 "

Calculated from the formula of acetate of silver.



yields 64.68 per cent of silver.

That portion of the mixed chlorides which distilled above 30° C. was fractionated, when two-thirds of the total volume distilled over between 57°–59° C. The specific gravity was found to be 1.198 at 6.5° C. Regnault found the sp. gr. to be 1.174 at 17° C. and the boiling point to be 64° C. (*Ann. Ch. Phys.* [2] lxxi. 355).* Submitted to analysis the following numbers were obtained:

No. 1. 0.5206 grm. gave 0.3691 grm. of chlorine.

No. 2. 0.4491 " " 0.3186 " "

No. 3. 0.4292 " " after drying over stick potash for a week, 0.3010 grm. of chlorine.

Percentage of chlorine found by No. 1, 70.89

" " " " No. 2, 70.94

" " " " No. 3, 71.76

The percentage required by the formula—



of monochlorinated ethyl chloride is 71.73.

Hence the monochlorinated ethyl chloride was formed in quantity by the action of excess of chlorine on di-methyl.

Having commenced the examination of the di-methyl obtained, 1st, by Frankland's method from iodide of methyl and zinc, and 2nd, by Schützenberger's process, I hope to communicate the results to the Society.

* Belstein (*Ann. Chem. Pharm.* v. 113–110) has shown that monochlorinated ethyl chloride, and chloride of ethylened, obtained by action on aldehyde with perchloride of phosphorus, are identical, the boiling point of the latter as observed by Wurtz is 58–59° C. and the specific gravity as determined by Gauthier is 1.189 at 4.3° C.; these numbers agree with those I found. Belstein remarks that the higher boiling point as observed by Regnault would result from the presence of higher chlorinated products.

NESSLER'S TEST FOR AMMONIA.

WE have had repeated applications for information on the subject of Nessler's test for ammonia. This is frequently referred to, but always in a way that assumes a knowledge of its details. We shall perhaps best consult the wishes of a large number of the readers of the *CHEMICAL NEWS* if we condense here the best descriptions hitherto published of this test. We take the following from two papers: one published by Professor W. A. Miller, in the *Journal of the Chemical Society* for May, 1865, and the other published by Professor Frankland and Mr. Armstrong, in the *Journal of the Chemical Society* for March, 1868. In each instance the authors recommend Mr. Hadow's modification of the Nessler test. Professor Miller writes:—

"Make a concentrated solution of an ounce or more of corrosive sublimate; having dissolved $2\frac{1}{2}$ ounces of potassic iodide in about 10 ounces of water, add to this the mercurial solution until the iodide of mercury ceases to be dissolved on agitation; next dissolve 6 ounces of solid hydrate of potash in its own weight of water, and add it gradually to the iodised mercurial solution, stirring whilst the mixture is being made; then dilute the liquid with distilled water till it measures one quart. When first prepared it usually has a brown colour of greater or less intensity, owing to the presence of a little ammonia; but if set aside for a day or two it becomes clear and nearly colourless; the clear liquid may then be decanted for use. For a litre of the test liquid of equal strength 62.5 grammes of potassic iodide, and 150 grammes of solid caustic potash will be required. About 50 grains (3 c.c.) of this solution are drawn-off by a marked pipette and added to one half of the distillate; * if no ammonia be present the mixture remains colourless, but if ammonia be present the liquid will assume a yellowish tinge of greater or less intensity. The liquid will remain clear if the ammonia do not exceed 1-200th of a grain in the 5 ounces, or about 0.25 mgm. in 125 grammes of the distillate. The quantity of ammonia in such a case may be very accurately estimated in the following manner:—A solution of sal-ammoniac is prepared containing 3.17 grains of the salt in 10,000 grains of water (or 0.317 grammes of salt per litre), which is equivalent to 1-10,000th of a grain of ammonia (H_2N) in each grain of this solution, or 0.1 gramme in 1 litre. Suppose that a tint is obtained in the distilled liquid which experience leads the observer to estimate say at 5-1000ths of a grain; 50 grains of the standard sal-ammoniac solution are placed in a beaker similar in size to that used for the distillate under trial, then diluted with 5 ounces of distilled water previously ascertained to be free from ammonia (an impurity not unfrequently met with in the first portions of water which come over in distillation); lastly, 50 grains of the mercurial test liquor are added.

"If the tint coincides in intensity with that furnished by the distillate which has received an equal quantity of the mercurial test, the amount of ammonia may be considered to correspond with that taken in the liquid for comparison. If the distillate appear to have a deeper or a paler tint, a second approximative trial with a larger or a smaller quantity of sal-ammoniac must be made, and so on until the operator is satisfied

that the tints coincide. On multiplying the number of grains of sal-ammoniac solution employed by 8, the product will give in 10,000ths of a grain the quantity of ammonia per gallon in the water under examination. Suppose that the observer estimates the amount of ammonia in the 125 c.c. on which he is operating, at 0.25 mgm., he takes 2.5 c.c. of the sal-ammoniac solution, and dilutes it with distilled water to 125 c.c.; he then adds 3 c.c. of the mercurial liquor, and compares it with the tint produced in the distillate by a like addition of the mercurial test. If the two tints correspond multiply by 2 the number of c.c. of sal-ammoniac solution required, and the number obtained will give the proportion of ammonia per litre in tenths of a milligramme. When the quantity of ammonia exceeds the 20th of a grain per gallon, or 0.6 mgm. per litre, it is necessary to determine the amount by neutralisation."

The description given by Messrs. Frankland and Armstrong is as follows:—

"Unless the amount of ammonia obtained by distillation alone, or with sodic carbonate, be considerable (about 0.1 part in 100,000 parts of water), Hadow's modification of Nessler's process is all that could be desired for its accurate determination. But if a larger proportion than this be obtained, the presence of urea [in a potable water] may be suspected, and it becomes necessary to make the Nessler ammonia test directly in the original water without the intervention of distillation. For this purpose, however, the water should be colourless, and free from calcic and magnesian carbonates. Any tint which is appreciable in a stratum 6 or 8 inches thick would obviously vitiate the result of a colour-test, whilst if calcic or magnesian carbonate be present, the addition of the Nessler solution will infallibly produce turbidity; moreover, we find that the slightest opalescence in the water, under these circumstances, is absolutely incompatible with an accurate determination. Both these difficulties might be effectually removed by adding to the water, first, a few drops either of ferric chloride or aluminic chloride in solution, and then a few drops of a solution of sodic carbonate, so as to precipitate ferric hydrate or aluminic hydrate. The precipitate completely decolourises the water, and no turbidity is caused by the subsequent addition of the Nessler solution; but, unfortunately, the precipitate carries down with it an amount of ammonia which, in the case of the ferric hydrate, sometimes amounts to one-third of the total quantity present. Remembering the beautiful blue-green tint—the natural colour of absolutely pure water—which is presented by a reservoir of water that has been softened by Clark's process, we tried upon peaty water the effect of precipitating in it calcic carbonate, and found that the decolourisation was as complete as could be desired, and that no appreciable amount of ammonia was carried down with the precipitate. The amount of calcic carbonate present in a coloured water is rarely sufficient to enable the operator to carry out this reaction with sufficient rapidity and completeness; it is therefore best in all cases to add a few drops of a concentrated solution of calcic chloride to half a litre of the water. The subsequent addition of a slight excess of sodic carbonate then produces a copious precipitate of calcic carbonate, which should be allowed to subside for half an hour before filtration. 100 c.c. of the filtrate is a convenient quantity to take for the direct Nessler determination of ammonia. To this volume of the filtrate 1 c.c. of the Nessler solution is added, and the

* The author is here referring to an operation described in a previous part of his paper, in which a distillate is obtained in which is present all the ammonia which is required to be estimated.

colour observed in the usual way. [See Professor Miller's paper, quoted above.] By this direct process, the ammonia in fresh urine can be readily estimated; for this purpose 5 c.c. of the urine should be diluted with 95 c.c. of water free from ammonia. We have ascertained that known quantities of ammonia, added in the form of ammoniac chloride to urine, can be determined with great accuracy.

"The colour observations of the Nessler determination are best made in narrow glass cylinders, of such a diameter that 100 c.c. of the water to be tested form a stratum about 7 inches deep. The depth of tint is best observed by placing these cylinders upon a sheet of white paper near a window, and looking at the surface of the liquid obliquely."

It would be a great advantage to all who are engaged in the analysis of waters if gentlemen who have been in the habit of employing Nessler's test, and have by experience learnt useful modifications in its application, would communicate them for insertion in our columns.

ARSENIC IN SUBNITRATE OF BISMUTH.

DR. GUNNING calls attention to the fact, that the metallic bismuth of commerce nearly always contains arsenic. He found on testing six different samples of the subnitrate of bismuth, as sold by respectable chemists at Amsterdam, that each of these samples contained arsenic; he instituted some experiments to find a ready mode of getting rid of the arsenic, and states that if even the metallic bismuth applied for the making of the subnitrate were contaminated with arsenic, the latter can be eliminated if to the nitric acid solution of the metal, just so much water is added as will suffice to produce a slight precipitate; this will contain all the arseniate of bismuth with a comparatively small proportion of subnitrate; the fluid has to be left until the precipitate has fully subsided, and the clear supernatant liquid may then be decanted, and on further addition of water the subnitrate of bismuth precipitated free from all arsenic. The rationale of this process is that the arseniate of bismuth is far less soluble in somewhat dilute acid, while still more than sufficient acid is present to prevent the nitrate of bismuth becoming converted into sub- or tris-nitrate, as it is called. It is true that by following this mode of manufacturing subnitrate of bismuth some loss is experienced of subnitrate; but the first sediments, if accumulated, may be boiled with a solution of caustic soda, whereby arseniate of soda is obtained, and oxide of bismuth, which latter of course can serve again for the preparation of the subnitrate with due care. In a medico-legal point of view, the fact that preparations of bismuth as applied in medicine may contain arsenic is of great importance.

ON THE PROPOSED WATER SUPPLY FOR THE METROPOLIS.*

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OUT of every thousand people existing upon this planet at the present moment, three live in London. Any matter, therefore, which intimately concerns the health and comfort of this vast mass of humanity, cannot but merit earnest attention; and, moreover, if that matter

be connected with scientific research, I feel sure that the members of this Institution will require no apology even for its being brought under their notice a second time.

A year ago, I discoursed to you about the chemical considerations respecting the present Metropolitan Water Supply, and I mentioned the five schemes then proposed to remedy its obvious and serious defects—excessive contamination with sewage, and great hardness—the first rendering it unfit for drinking, and the second disqualifying it to a certain extent for washing and cleansing purposes. Those schemes to which I alluded on the last occasion were the following: *First*, the sources of the Severn, proposed by Mr. Bateman; *second*, the Cumberland lakes, proposed by Messrs. Hemans and Hassard; *third*, the Thames water filtered through the Bagshot sands, suggested by Mr. Telford Macneill; *fourth*, extensive reservoirs constructed near the sources of the Thames, the scheme of Mr. Baily Denton; and *fifth*, the waters flowing down the slopes of the Derbyshire and Staffordshire hills, proposed to be brought to the Metropolis by Mr. Remington.

At that time the quality of the waters obtainable by any of these schemes had been but little investigated, and that remark still applies to the last three schemes. But in the interval, the water yielded by the two first-named districts has been, at the instance of the Royal Commission on Water Supply, submitted to a searching chemical investigation by Dr. Odling and myself, and I am therefore enabled on the present occasion to speak with confidence as to the quality of the water from both these districts.

There are also one or two points of general scientific interest which have been brought to light during this inquiry, and which I also propose to touch upon:—These are, first, the curious effect of detritus from mines upon the quality of the water with which it is mixed; and secondly, the conditions which determine the action or non-action of water upon lead.

During the past year the processes of water analysis have undergone a complete revolution. It is one of my duties to report monthly to the Registrar-General upon the quality of the Metropolitan waters, and in carrying out this work I found the methods of water analysis hitherto employed so untrustworthy as to render an almost entire remodelling of them absolutely necessary.

I propose, therefore, first to glance shortly at some of the innovations which have been made in this branch of chemical analysis. When water is to be submitted to chemical examination, it is of the utmost importance to have a sufficient and well-collected sample. On this occasion the completeness of the investigation, as regards the two proposed schemes, has been very materially assisted by the judicious choice of samples supplied by Dr. Pole, F.R.S., who went down to the districts and collected the samples which were afterwards submitted to chemical analysis by my colleague and myself.

The first thing to be determined in a water analysis is the "total solid impurity," as it is termed, i.e. the total amount of solid matter with which the water has been contaminated since it was submitted to the natural process of distillation. This quantity of solid impurity is determined by taking a known volume of the water and evaporating it down to dryness in a previously weighed platinum vessel. The solid impurity contains both organic matter and inorganic or mineral matter. The most important of these two classes of

* Read before the Royal Institution of Great Britain, Friday, April 3, 1868.

substances contained in the solid residue is undoubtedly the organic matter. Now, even at the present moment, the actual weight of this organic matter cannot be determined by chemical analysis; in fact there is no process known to science by which its weight can be even approximately estimated; but it is possible to determine, in a given bulk of water, the quantity of the two principal constituents of this organic matter, *viz.* the carbon and nitrogen which enter into its composition. For this purpose a separate quantity of the water is evaporated down to dryness; but in this case the process is conducted in a glass vessel, and before evaporation the water is mixed with sulphurous acid in order to expel the carbonic acid, which is partly dissolved in the water and partly combined with lime and magnesia. Other precautions also have to be taken, but I hesitate to enter into the details, which I fear would only weary you. However, I think that it is desirable just to show you the general plans on which the determination of the organic carbon and nitrogen, in the residue thus obtained by evaporation in the glass dish, is effected. The operation is performed in the following manner:—The contents of the glass vessel are very carefully scraped out and rubbed off the sides of the vessel by a substance known as chromate of lead, a finely powdered somewhat gritty material, which very completely effects this object, and enables us to transfer the water residue gradually into a piece of hard Bohemian glass tube closed at one end. This tube is then filled up to within about four inches of the mouth with coarsely granulated oxide of copper, and upon that is placed a small quantity of bright metallic copper to decompose oxidised compounds of nitrogen. The tube is then laid in a gas furnace, called “the combustion furnace.” Before combustion commences the entire tube is made perfectly vacuum, all the air is pumped out of it, so as to get rid of the atmospheric nitrogen which would vitiate our result. This is done by means of a mercurial pump invented by Dr. Sprengel, by means of which we can extract almost the last trace of atmospheric air contained in the tube. The latter is then gradually heated to redness, during which process the carbon and nitrogen of the organic matter in the water residue are converted, the first into carbonic acid gas, and the second into nitrogen and nitric oxide gases. From the volume of each of these gases the weights of carbon and nitrogen can be calculated with great precision. (Experiments performed.)

Now the nitrogen in the result of the analysis is also derived from any ammonia present in the water, and it is therefore necessary to determine how much is due to that source. This estimation of ammonia is perhaps the only *rapid* and *easy* process connected with water analysis which may at the same time be regarded as satisfactory. For these simple processes of analysis when they come to be rigorously tested generally prove to be very incorrect; but this has survived the test of experience, and is capable of determining the result with great precision and readiness. I have here five glass cylinders. The water in the first contains no ammonia at all; the second contains a certain small quantity; the third twice as much as the second; the fourth three times as much, and the fifth four times as much as the second. To each of these vessels I shall now add an equal volume of a test solution, which strikes a peculiar yellow or orange-yellow colour with the ammonia in the vessels. This is known as the Nessler test, having been invented by a German chemist of

that name. (The experiment was performed, the water in the four last vessels assuming different shades of orange colour, in proportion to the quantity of ammonia contained in them; the water in the first vessel remaining colourless.)

Now we have still one other process at which it is necessary to glance for a moment, *viz.*—the process for determining the nitrogen existing as nitrates and nitrites. It is called combined nitrogen, but it is not organic nitrogen, although it has in most cases been derived from organic matter. The water residue used for the determination of the amount of solid impurity is dissolved in a small quantity of water; sulphate of silver is then added, by which the chlorides are converted into sulphates. The resulting liquid, after filtration, is transferred to the upper part of a glass tube filled with mercury. It requires to be mixed with rather more than its own weight of sulphuric acid, which is introduced in the same way. It is then only necessary to shake up this mixture, the mouth of the tube being closed with the thumb. Very soon the mercury begins to act on the nitric acid, converting it into a colourless permanent gas called nitric oxide, which only requires to be measured in order to determine the amount of nitrogen originally present in the water in the shape of nitrites and nitrates.

There is only one other determination I will trouble you with, and this I do principally for the purpose of introducing to your notice a very ingenious piece of apparatus, an application of the Sprengel pump, which has just been contrived by my assistant, Mr. McLeod. It is designed to extract the gases which are dissolved in waters. By this instrument we can not only measure the whole of the gases present in the water, but we can determine how much of the gases can be expelled at the ordinary temperature, and how much more will come off when you boil the water *in vacuo*. This gas is then submitted to the usual eudiometrical investigation, to ascertain the quantity of carbonic acid, nitrogen, and oxygen—the three gases which almost invariably occur in the waters submitted to analysis. (Apparatus shown at work.)

Now it is not necessary for me on the present occasion to go at all into the details as regards the sources of the two proposed water supplies for London. This I did on the former occasion pretty fully. I will only refer you for a moment to the large map before you, which shows the districts from which the supplies would be taken and the course of the conduits to the metropolis. By the Welsh scheme, the water would be collected on the slopes of Cader Idris and Plynlimmon, from whence it would be brought by a conduit to within 10 miles of London, where it would be stored in reservoirs 400 feet above high-water mark. The other scheme proposes to bring the water from the lakes of Cumberland, past several large towns, laying under contribution the Bala Lake, in Wales, if necessary, and the combined waters would then be brought to the metropolis after distributing a certain amount to the large towns on their route.

It is, perhaps, necessary just to say a word or two in order to disabuse your minds of the idea that these schemes are intended to inflict any injury upon the present water companies. Ample provision is made in these schemes for the complete compensation of the existing companies, and the only conceivable mischief in this respect which can be done by the adoption of one scheme or the other, would be the abolition of certain Boards of Directors which now exist, for the

administration of the affairs of the eight or nine companies which supply London.

These schemes are of course very costly. It quite staggers one at first to think of the amount it is proposed to expend upon them. Thus, Mr. Bateman's scheme, which is to bring water from the mountains of North Wales, is calculated to cost, for a supply of 220,000,000 gallons per day, the sum of £10,850,000; whilst the scheme for bringing water from the lakes of Cumberland is put down, for 250,000,000 gallons a day, at £13,500,000. Now these are startling figures; but I imagine that all we have to look at is the simple question, How much shall we have to pay for the water when these schemes are carried out? If you go into that matter you will find, according to the calculations of the engineers—I will not say they are always to be implicitly relied upon, perhaps a certain percentage must be allowed—but taking their calculations as correct, it actually follows that after compensating the existing companies, and after expending this enormous amount upon the works, we shall be supplied with this very pure water at a less cost than that which we pay at the present moment. We pay at present about 1s. 5d. in the pound of rent for water. By Mr. Bateman's scheme we should be charged a domestic rate of 10d. in the pound, or two-thirds of what we now pay, *plus* a public rate of 2d. Messrs. Hansard and Heman's scheme would be met by a domestic rate of 1s. 1d. in the pound. Now I think, if we are actually to be gainers by this transaction, the enormous sums necessary to be expended on these works need not frighten us, and need not prevent us from taking them into our serious consideration.

Let us just pause for a moment to consider the purely mechanical relations of the proposed to the present Metropolitan supply, because this will somewhat help you to comprehend how it is that, having expended all this money upon the works, we shall still have water cheaper. In the first place, every gallon of water which is now delivered in London has to be pumped up from nearly the sea level, to an average height of about 250 feet. Then, again, the present supply is intermittent; the proposed will be constant. With regard to the pumping part of the process, that in the proposed scheme would be replaced by the work of gravitation. The gigantic and magnificent engines employed at the present moment in London for raising this vast volume of water—100,000,000 gallons daily—are painful for the philosopher to contemplate. You have here a stupendous waste of power employed in doing over again an amount of work which was previously executed for us gratuitously. The sun, in his prodigality of power, flings up far above the cross of St. Paul's this daily supply of 100,000,000 gallons, and we, in our imbecility, allow it to soil itself by flowing down again nearly to the level of the sea, and then we erect immense pumping engines and expend 200 tons of coal daily to raise this water a fraction of the height from which we had previously allowed it to fall. All this will be saved by the proposed schemes.

We talk of the exhaustion of our coal fields and of the necessity of conserving our supply as much as possible, and although the amount thus saved would make but a poor figure in Mr. Jevon's 100,000,000 tons a year, yet this is a kind of work which can be done better by solar heat than by the action of coal; and it is not very often that we are thus able to substitute, with advantage, natural for artificial force.

Now with regard to the quality of these waters

which it is proposed to bring to London, you have in the following tables a comparative statement, showing the results obtained by the analysis of the proposed Welsh and Cumberland waters, and of the present Metropolitan water supply:—

TABLE A.—Results of Analysis of Welsh, Cumberland, and London Waters.

100,000 PARTS OF WATER GAVE—			
	WELSH. Mean.	CUMBERLAND. Mean.	LONDON. Mean.
Total solid impurity.....	4.85	4.74	32.66
Organic Carbon.....	.460	.276	.270
Organic Nitrogen.....	.006	.010	.025
Ammonia.....	.003	.002	.003
Nitrogen as Nitrates and Nitrites.....	.017	.009	.323
Total combined Nitrogen..	.025	.021	.354
Previous sewage or manure contamination.....	47	6	2930
Hardness.....	1.4	2.2	20.13
Lime.....	.599	1.113	9.822
Magnesia.....	.288	.272	.890
Potash.....	.126	.158	.851
Soda.....	.679	.532	1.666
Sulphuric Acid.....	1.093	.969	3.674
Carbonic Acid.....	.201	.691	7.187
Silica.....	.254	.133	.834
Chlorine.....	.876	.490	1.480

TABLE B.—Analysis of London Waters, 1867–68.

100,000 PARTS OF WATER CONTAINED—					
	Total Solid Impurity. Mean.	Organic Carbon. Mean.	Organic Nitrogen. Mean.	Previous Sewage Contamination. Mean.	Hardness. Mean.
THAMES.					
1867.....	28.5	.272	.013	2062	19.3
Jan., 1868.....	30.9	.399	.048	3150	17.3
Feb. ".....	31.4	.339	.043	3010	19.3
Mar. ".....	30.0	.216	.028	2388	19.3
RIVER LEA.					
1867.....	27.5	.196	.005	1611	19.3
Jan., 1868.....	33.1	.131	.019	3030	21.6
Feb. ".....	32.6	.244	.031	3320	20.5
Mar. ".....	28.7	.088	.016	2115	19.5
KENT CO.					
1867.....	39.3	.213	.002	3619	25.6
Jan., 1868.....	44.8	.064	.013	3770	26.2
Feb. ".....	59.2	.081	.013	5330	30.0
Mar. ".....	70.2	.093	.029	3680	32.3

The quantity of the solid impurity contained in a water is a very important matter, apart from the consideration of the quality of the substances which compose this impurity. Waters leaving a small amount of residue upon evaporation are usually well fitted for domestic use. They are invariably the best for manufacturing purposes, as they effect a great saving in heat when used for steam boilers. I was shown the other day some cakes of carbonate of lime, a quarter of an inch thick, which had been removed from a locomotive boiler at the Deptford Railway Station, in which they had been formed in forty-eight hours; through this substance heat passes with extreme slowness, so that a considerable quantity of fuel is wasted. It will be seen from the first of the above tables that, on an average of all the samples, the total solid impurities amount in the two schemes to about 1-7th of those in the present water supply; but if we might venture to take the water in the proposed large storage reservoirs

as equal in this respect to the water now stored in the lakes, it would be about 1-10th of that which is found in London waters.

Now this solid residue is partly mineral and partly organic. Let us glance first at the organic portion. This organic matter present in the original water may be either living or dead. The detection of the former class of impurities belongs more to the province of the naturalist than to that of the chemist; but it may be remarked in passing, that this form of organic impurity must necessarily be in suspension and not in solution. We cannot conceive of organised beings existing in solution—it is impossible. But it does not from this follow that these suspended matters can be removed from water by filtration.

It is well known that the ova of many species of animalcula cannot be removed thus, they pass through the best filters; and it has also been proved that what is believed to be the cholera poison passes through filters, and cannot be arrested. This is a most important consideration in connection with water which is contaminated with sewage and manure matters; and it is necessary that such water should, at all events, be as well filtered as possible. The present water companies supplying London cannot possibly be blamed for the original quality of the water which they supply. They cannot hinder the 600,000 persons who live on the banks of the Thames from pouring their refuse into the river; but they can filter this impure water. They can, and indeed by Act of Parliament they are supposed to be compelled to deliver this water in a bright, transparent, and filtered condition; and they can in this way, as far as it is possible by filtration to do it, remove these suspended organic contaminations from the water.

But how does the matter stand? Here is a sample of water which I drew from the Lambeth company's main on the 4th of March. You see that the water is not filtered. It is filtered by Act of Parliament! but it is curious to observe that so much pollution can pass through an Act of Parliament. Here too is a sample of the same company's water collected on the 21st of January; and it is a fact, that during the whole of that interval and almost up to the present time, this water has been much in the same condition. Those of my audience who are supplied by the Lambeth company, or the Southwark and Vauxhall company, or by the Chelsea company, will bear me out as to the condition in which those companies have delivered water during the past two months. In fact, not only for the past two months, but during the entire year, water is often delivered in London very imperfectly filtered. The Southwark company during the whole of last year, with one exception, delivered from its mains, when the samples were drawn for analysis, turbid water, imperfectly filtered—most of the other companies were to a less extent guilty of the same thing. Of the companies which draw from the Thames, the West Middlesex and the Grand Junction are the two which filter their water best; but the only company which delivered water uniformly transparent and well filtered was the New River company.

I have stated that the absolute quantity of the organic matter in solution in water cannot be ascertained, but the amount of carbon and nitrogen contained in this organic matter can be estimated by the process of combustion which I have exhibited to you. The amount of organic carbon and nitrogen in the several waters I have referred to, is represented in the second and third

lines of table A, and in the second and third columns of table B you will see that, with regard to these elements of the organic matter in solution, there is not a very striking difference between the three different classes of waters. There is an excess of organic nitrogen in the case of the London waters, and of organic carbon in the case of the Welsh waters.

The organic matter, of which the elements are thus determined, may be either animal or vegetable, and the nature of it has much to do with the probability of its being noxious or innocuous. The animal or vegetable source of the organic matter may be judged of by the proportion of nitrogen to carbon, as determined by analysis: that from animal sources contains a larger proportion than that derived from vegetable sources; and in this way it is easy to see that the organic matter in the Welsh and Cumberland waters is of a different character from that contained in the London waters. The London river-waters, especially when turbid, contain a much larger proportion of nitrogen to carbon than is contained in other waters, thus proclaiming the animal origin of some portions of the organic matter.

When I addressed you on this subject last year I stated that by operating upon one litre of water, one per cent of unchanged sewage could be detected with certainty, but that smaller percentages ought, in operations upon such a small quantity of water, to be considered as falling within the possible errors of experiment. In like manner, by operating upon 10 litres of water 1-10 of a per cent of unchanged sewage could be detected. During the past year, however, this process of analysis has been so improved that an amount of organic nitrogen corresponding to at most 3-100ths of a per cent of unchanged sewage can now be detected with certainty in one litre of water. Now about 4-5ths of the organic nitrogen contained in *perfectly fresh* sewage exists there as urea, which undergoes such rapid decomposition into the mineral compound carbonate of ammonia, that little or none of it ever reaches the Thames from the towns whose sewers debouch into this river. As average London sewage contains 10 parts of combined nitrogen in 100,000 parts, it follows that 100,000 parts of this sewage as it flows into the Thames will contain only 2 parts of organic nitrogen. Further, if the sewage of the 600,000 persons who drain into the Thames above the point whence the water companies draw their supply have the strength of average London sewage, it will amount to 18,000,000 gallons daily, and if the average flow of the river at Teddington be taken at 800,000,000 gallons daily, it follows that the river will there contain 2250 parts of sewage in 100,000 parts, or 2½ per cent. This quantity of sewage, if in the condition as delivered at the sewer outfall, would contaminate the whole volume of the river, only to the extent of .045 part of organic nitrogen in 100,000 parts of water. Now on the 21st of January last the water delivered by the five companies drawing their supplies from the Thames contained the following amounts of organic nitrogen in 100,000 parts:—

Chelsea (turbid)	·058	Grand Junction (clear)	·031
West Middlesex (clear)	·027	Lambeth (turbid) . . .	·062
Southwark (turbid) . .	·061		

It will be seen, therefore, that three out of the five samples of water actually contained more organic nitrogen than would be due to the admixture of the 18,000,000 gallons of sewage which are poured into the Thames above the point from which these samples came. But Thames water holds in solution a certain amount

of peaty matter which contains organic nitrogen; a sufficient proportion of this substance, however, to furnish the above larger quantities of organic nitrogen would render the water brownish yellow when viewed in a quart decanter, whilst these samples of Thames water were, when filtered, colourless or nearly so. I am therefore of opinion that the Thames water delivered in London by the Chelsea, Southwark, and Lambeth companies on the 21st of January last contained unoxidised sewage. This opinion is confirmed by the results of some experiments which I have recently made in my laboratory, and which show that, contrary to the generally received opinion (which is, however, based upon no reliable experimental data), sewage in which the uræa is already decomposed undergoes further change with extreme slowness, even when freely exposed to the air and mixed with large volumes of water. Thus I find that a mixture of weak sewage from one of the London sewers with nine times its volume of water (containing bicarbonate of lime in solution) at a temperature of 20° to 25° C., and well agitated every day by being made to flow in a thin stream through 3 feet of air, oxidises but to a slight extent in the course of eight days. Immediately after mixture this sewage-contaminated water contained '267 part of organic carbon and '081 part of organic nitrogen in 100,000 parts, whilst after 96 hours it still contained '250 part of organic carbon and '058 part of organic nitrogen, and even after the lapse of 192 hours the undecomposed organic matter still contained '200 part of organic carbon and '054 part of organic nitrogen.

In connection with the organic matter in water, the investigation of the Welsh and Cumberland samples revealed a very curious effect produced by the admission of the detritus from lead and other mines into the waters of the streams and lakes. It was found, upon analysis, that water thus mixed with the milky streams from the crushing engines of mines, contained a wonderfully small quantity of nitrogenous organic matter. You will see this brought out in the following table:—

Effect of Detritus of Lead Mines upon the Organic Matter in Water.

	Organic Carbon in 100,000 parts of Water.	Organic Nitrogen in 100,000 parts of Water.
CUMBERLAND WATERS.		
Glenridding Beck.....	'116.....	'000
Stream flowing into Thirlmere...	'066.....	'001
Goldrill Beck.....	'262.....	'001
WELSH WATERS.		
Ceryst	'209.....	'000
Upper Clywedog.....	'544.....	'000
Lower Clywedog.....	'242.....	'001
Tarannon and Ceryst.....	'304.....	'001

This table shows that whilst some of these waters exhibit a rather large quantity of organic carbon, they contain very little or no organic nitrogen. And further, these waters, though they hold in solution a considerable amount of peaty matter, are perfectly colourless when seen in a quart decanter; but when viewed through a stratum 15 feet thick they exhibit the magnificent blue-green tint of absolutely pure water, a tint which is brought out when water is passed through animal charcoal. We may illustrate the action of this crushed quartz of lead mines and of animal charcoal, by three samples of the water delivered

to this Institution by the Grand Junction Company, and which are contained in the tubes before you, each of which is 15 feet long. The centre tube contains the water just as it passes into the cistern, the water in the second tube has been shaken with powdered flint, whilst the water in the third tube has been passed through animal charcoal. If we now send through each tube a parallel ray of electric light, which ray will have to pass through a stratum of about 15 feet of water, you will perceive that the first gives a yellow-brown tint upon the screen; the second, a beautiful green tint, and the third, a turquoise colour; the last two powerfully reminding the observer of the lakes of Lauerz and Zug, as seen from the summit of the Rigi. (Experiment performed.) In fact this is doubtless the chief cause of that magnificent colour which we witness in many of the Swiss lakes, and which we see for instance in the Rhone when it leaves the lake of Geneva, and the Limmat as it flows from the lake of Zürich. The streams running into the heads of these lakes come in turbid and filled with finely crushed quartz and other minerals, the detritus from the glaciers which are the source of those streams. In the lakes, these fine peaty particles of mud subside and attract to themselves the colouring matter which is to be found in almost all waters.

We see in two of the English lakes some indications of this blue-green tint appearing, and it is precisely in the localities where the streams from the lead mines come down into the lakes. You see near the mouths of those milky streams which come down into Ullswater from Glenridding, and from the "Old Man," into Coniston Lake, the indications of this precipitation and removal of those brown substances which discolour the natural waters of our lakes. We have thus here, perhaps for the first time, evidence of improvement of the quality of water by the admission into it of manufacturing refuse. Hence the diversion of these waters coming from lead and other mines, which would seem at first sight to be necessary, need not be effected; on the contrary, their admission into the lakes would be of great benefit to the waters, they would to some extent decolourise them, and would tend to reduce the nitrogenous organic matter to the lowest possible amount. There appears to be no need to fear that such streams will carry anything into the lakes which will be deleterious to the drinker. All those streams have been carefully examined for lead, arsenic, copper, &c., and only in two cases has the faintest trace of lead been discovered, and the quantity was so minute that it is absolutely impossible it could be deleterious, even if the water coming from the mines themselves were to be drunk, but mixed with the large quantities of the lake water, it becomes utterly inappreciable.

The fatal effect said to be exerted upon fish by these milky streams from mines is most probably due to a mechanical action of the finely divided quartz upon their organs of respiration—an effect analogous to that (but of an exaggerated kind) from which the Sheffield grinders notoriously suffer.

ON THE

ESTIMATION OF SULPHUR IN COAL GAS.

M. ALBERT ELLISSEN, Engineer, chief of the Experimental Works of the Paris Gas Company, has forwarded the following communication to the Editor of the *Journal of Gas Lighting*, in reply to the article by Mr.

Valentin, principal assistant in the Royal College of Chemistry. (*Vide CHEMICAL NEWS*, Feb. 21, 1868, Vol. XVII., p. 89. *Am. Repr.*, April, 1868, p. 165.)

"The question of the estimation of sulphur in purified coal gas, which has for many years occupied the attention of engineers and of the public in England, should be considered from two points of view altogether different, which I shall call the theoretical and the practical views of the question.

"Looking at it theoretically, or from the scientific point of view, the object is to determine the mathematically exact quantity of sulphur in the gas. When viewing the question practically, it is necessary to ascertain the causes which obstruct the detection of that substance, and to determine the quantity which, during the combustion of the gas for domestic purposes, might produce an effect injurious to health, or be destructive to furniture, books, &c. Does the process mentioned by Mr. Valentin accomplish either of those objects? I think not, and I will endeavour to show why.

"His process, which consists in burning gas mixed with air when passing over spongy platinum, is not new, a similar arrangement having been used in 1864, by Dr. Letheby, in his experiments on the sulphide of carbon in gas. Even according to Mr. Valentin, that method does not determine the total quantity of sulphur in the gas, and I think that is less owing to the imperfect absorption of the sulphur products, or to the difficulty of extracting them from the platinum by washing, than to the imperfect combustion of the sulphur; and I have no doubt that, if Mr. Valentin were to substitute pure oxygen for atmospheric air in his experiments, he would obtain much more favourable results, and probably obtain the whole of the sulphur contained in the gas. But it appears to me that the process adopted in my experiments, afterwards repeated by Mr. Alfred Anderson and by Mr. Valentin, which consists in passing the gas over quicklime or soda lime, heated to redness in a drawn-iron tube, is more simple than that of Mr. Valentin, as it does not require the making of oxygen for special aspiration, and gives exact mathematical results of the quantity of sulphur in the gas. I cannot admit that the use of nitric acid or of hypochlorites can occasion the least difficulty to experimental chemists.

"In reply to the doubt expressed by Mr. Valentin as to the correctness of the proportions I obtained by means of lime in 1864, I wish him to bear in mind that those experiments were made at the experimental works of the Paris Gas Company, expressly on gas obtained by varied distillations of coal of the most different kinds possible; which circumstance explains the great differences in the results obtained.

"Let us look, however, to the practical part of the question, which, in point of fact, will constitute the only interesting part of the discussion that will probably take place this year, in considering any measure on the subject to be brought before Parliament. In the reports of Dr. Letheby to the Commissioners of Sewers of the City of London, on the sulphur compounds in gas, which must be first considered, he states that, during the combustion of gas, the sulphur it contains produces sulphurous and sulphuric acid, which injure furniture, and especially books in libraries. I will not again discuss what value is to be placed on that statement, for I have previously shown how many other causes contribute to the production of sulphuric acid in the atmosphere of large towns; but there can be no doubt that,

if it be admitted that any damage is really done by the sulphur in gas, it can only be the portion of it which is converted by combustion into sulphurous or sulphuric acid that can really produce any injurious effect. The other portion of the sulphur, which is not consumed, and which consequently escapes into the atmosphere in the form of sulphide of carbon or vapours of sulphuretted organic products, cannot have any corrosive action. Why, therefore, should any trouble be taken to devise complicated apparatus to make it apparent? The practical problem then remains, to provide an apparatus by which all the sulphurous products during the combustion of gas, in the ordinary methods in use, can be completely ascertained; and I think that the apparatus contrived by Dr. Letheby, which is generally employed in England, fulfils all the conditions required for that kind of experiment.

"In that apparatus the gas is consumed with a Leslie's burner, under the best practical conditions for a good oxidation of the sulphur contained in the gas. The consumption with that burner is so slow, that certainly during the ordinary burning of gas so perfect a combustion does not take place, and which may be made similar to the blue flame necessary in heating apparatus—a mode of consumption which should be taken into consideration in the use of gas for domestic purposes. The condensation of the sulphur products (sulphurous and sulphuric acids) in the glass cylinder is complete; experiments having proved that a sensibly greater amount of sulphur is not obtained by increasing the number of those vessels, not by filling them with ammonia. The apparatus of Dr. Letheby has the additional advantage that the experiment may be made on the average quality of the gas manufactured during the day of twenty-four hours, and does not require the least superintendence. An interval of a few seconds is sufficient to empty the liquor collected in the cylinder, the quantity of which affords a valuable check on the correctness of the progress of the experiment, and a fresh experiment may be immediately commenced by merely opening the stop-cock for the gas.

"In a practical point of view, Mr. Valentin's apparatus is far from offering the same advantages. In the first place, the gas is consumed or decomposed under conditions not in the least like the usual manner of burning gas in private houses, and though the apparatus does not estimate the whole of the sulphur in the gas, nevertheless in these experiments a part of it is taken cognisance of which practically is not of the least interest, as it generally escapes into the air in a form that is not injurious. Furthermore, the apparatus is complicated; it requires difficult manipulation, a complicated fitting up and taking down, a continued superintendence during the whole time of the experiment, in order to supply an adequate quantity of air to the tube; and, as the experiment lasts only a few hours, the average quality of the gas made during the day cannot be ascertained. In short, I believe that this very ingenious apparatus of Mr. Valentin's is adapted exclusively to the laboratory, as it can only be used by an experimental chemist, and that it does not possess that practical working character required in a testing apparatus that is to be used rather by intelligent workmen than by men specially devoted to scientific pursuits.

"In conclusion, long consideration of the subject of the sulphur contained in purified gas has induced me to regard the simple apparatus of Dr. Letheby as the one which best fulfils the practical conditions of an

instrument for testing the quantity of sulphur which, unfortunately, the progress of science has not yet succeeded in completely extracting during the manufacture of gas.

"Paris, April 15, 1868."

The Editor of the *Journal of Gas Lighting* appends the following note to this communication:—

"We are informed that Dr. Lethby made a large number of experiments, in 1854, with an arrangement on the same principle as Mr. Valentin's, the products of the burnt gas being passed with an excess of atmospheric air through a mass of very fine platinum wire, at a temperature a little below redness; and the results were so unsatisfactory that the process was abandoned. Dr. Lethby also endeavoured to estimate the sulphur by passing the gas through a glass tube filled with small pieces of caustic baryta (obtained from the nitrate by ignition), and kept at a red heat; but as the process could not be continued for 24 hours—the time necessary for a fair analysis—this also was abandoned."

FOREIGN SCIENCE.

PARIS, APRIL 28, 1868.

*Tar-water.—Extraction of the colouring matter from madder.
—Petroleum in Galicia.*

THE medicinal properties of tar-water administered externally and internally in the treatment of various diseases of man and other animals are well known. Up to the present time this solution has not been manufactured in such a way as to contain a fixed proportion of tar. M. Guyot de Grandmaison, an intelligent chemist, has succeeded in obtaining a tar liquor perfectly capable of mixing with water, and containing a certain percentage of resinous matter. The application of his concentrated definite tar liquor has been attended with the greatest success, and this new preparation has, according to a report of one of our best practitioners, "*comblé une véritable lacune.*" Several trials were made with this article, in fifteen public hospitals in Paris, with the best results. This is a most natural consequence of the solution of tar, containing in a small volume all the active and medicinal portions of the tar, to the exclusion of the bitter empyreumatic principles always disagreeable to a sick palate, and often injurious to certain affections. No foreign substance is allowed to enter that can alter, suspend, or complicate the expected and precise effects of the medicament. The effects are produced by the tar alone, and by no other ingredient. Starting from the fact that two tablespoonfuls of the liquor, added to a litre of water, constitute a tar water of average strength, and always constant, it is easy to increase or diminish the intensity at will. Pure, or mixed with water, the concentrated tar essence can be put to a variety of new usages which were not available for want of a convenient method of administration; in fact, ordinary tar-water was so slow in action that it had almost been set aside. A number of uses will at once suggest themselves to medical men; among the uses to which this new liquid is applicable, the following may be mentioned—the treatment of infectious wounds, skin diseases, small-pox, neuralgia, and rheumatism. In the shape of vapour, the tar-liquor has been frequently used with success in cases of pulmonary consumption and bronchitis. M. E. Guyot's address is Rue des Francs Bourgeois, 17; the success of his preparation is well deserved.

A process for the extraction of the colouring matter of madder has been patented by M. Guignot. This process only differs from that patented by M. Leitenberger, in garancine being operated upon instead of madder. In an exhausting apparatus, the garancine is submitted to treatment with boiling water. As soon as the water has passed through the filter, it is replaced by more, until the garancine is completely exhausted.

Each quantity of hot water that has passed through is charged with a large proportion of colouring matter, which is nearly pure; by mixing all the coloured filtered liquors, and allowing the solution to cool, and repose a sufficiently long time, the colouring matter, previously kept dissolved by the heat, gradually becomes less and less soluble, and at last precipitates to the bottom of the vessel. The supernatant liquid, which is almost colourless, is decanted, and the deposit thrown on to calico filters to drain, afterwards being dried sufficiently to enable the colouring matter to be transported in commerce, in the shape of powder. Garancine is obtained by submitting ground madder, exhausted by water of all soluble principles, and again dried, to treatment with concentrated sulphuric acid at a temperature of 100°. The ligneous, glucous, and pectous matters under this treatment become carbonised, while the colouring matter is left intact; washing with a little cold water removes the adhering acid, and matters which have been rendered soluble. M. Leitenberger's process was made to operate upon the madder-root itself. He first exhausted with water at 45°, afterwards with boiling wood spirit, and these operations he carried out in apparatus perfected and patented by himself.

Mineral oils are now found and worked in other countries besides the United States; just now, Galicia is attracting attention as a valuable source for these oils. In West Galicia, mineral oil abounds; the principal petroleum reservoirs in this tract are found in the mountains enclosed by Limanowa, Neusandec, Grybow, Cieskowice, Gorlice, and Sbiszyce, covering an area of about 20,000 hectares. The ground is so charged with mineral oil, that it frequently issues in the form of springs, and it always suffices to bore 10 or 15 feet below the surface, to encounter the valuable substance. Despite the primitive modes of extraction employed, Western Galicia was able to extract in 1866 about 268 tons weight of petroleum. Several American engineers have visited the country; according to their accounts, the little river Dunajec has a fair chance of becoming the European Oil Creek. Geologists and engineers who have carefully examined the country on all sides, consider the petroleum of Eastern Galicia to resemble that of Canada, while that from the western part of the province is almost identical with Pennsylvanian oil. In this latter portion, namely, the western, there are sources of oil which the American wells do not yield in purity and abundance; worked with intelligence, they would doubtless yield such fortunes as those in America have.

PARIS, MAY 6, 1868.

Reduction of phosphide of iron minerals.—Prisms of constant deviation.

CONSIDERING the extent of the iron manufacture in England, the abundance of phosphoric iron ores, and the prejudicial influence exerted by phosphorus upon iron, M. Caron's research on the reduction of phosphide of iron minerals deserves space in these columns, if not, which we are far from saying, from its own intrinsic merit. To this savant we are already indebted for a former research upon the metallurgy of iron; he then showed that the addition of oxide of manganese to the blast-furnace charge eliminated a considerable part of the sulphur and silicon which passed into the slag. Since then he has observed that this oxide (oxide of manganese) while acting energetically in the expulsion of silicon and sulphur, is powerless with regard to phosphorus. Many sterile experiments were made, but one method gave, under certain circumstances, appreciable and satisfactory results. In the majority of cases, the phosphatic minerals worked for iron contain the phosphorus in the state of phosphate of iron, alumina, or lime; to counteract the pernicious influence of phosphoric acid it has been customary to mix these minerals with lime, which alone, up to the present, has appeared able to separate the phosphorus from the iron. Unfortunately, these phosphates mixed with lime are almost infusible, and a large proportion of silica is therefore obliged to be added to render the slag sufficiently fluid. M. Caron inquires,

What passes under these circumstances? Three substances are found together, phosphates, silica, and carbon, exactly as in the process indicated by M. Wöhler for the preparation of phosphorus: there is on the one side a siliceous slag, on the other iron, carbon, and free phosphorus, which naturally enters into combination, and forms a phosphoric iron. This reaction, M. Caron maintains, is undoubtedly that which takes place, for analysis shows the slags of the blast-furnace, operating with phosphatic minerals, to be free from phosphorus, while the resulting iron seldom contains an inoffensive amount of this element. Admitting that lime removes the phosphoric acid from the oxide of iron, evidently what is required is a flux other than silica, capable of dissolving phosphate of lime without decomposing it. Fluoride of calcium has appeared *à priori* best able to fulfil these conditions. Kryolite and other fluorides would doubtless produce the same effects. A mixture of phosphate of lime and fluoride of calcium was placed in a crucible of gas-retort carbon, covered externally with wood charcoal, and enclosed in an earthen crucible; a mixture of phosphate of lime and silica was placed in the same conditions. Thus prepared, the two crucibles were heated to the temperature of the fusion of steel. The carbon crucible containing the silica and the phosphate was completely pierced; there remained the melted silicate of lime, but the phosphorus had disappeared. The crucible containing the fluoride of calcium was intact, a slight bed had been eaten in, probably due to the presence of a little silica; the button was phosphoric, and became luminous under the blow of a hammer. It was then certain that fluoride of calcium could dissolve phosphate of lime without occasioning any decomposition. Experiments were therefore made upon phosphate of iron. (1.) A mixture of suitable quantities of pure phosphate of iron, lime, and fluoride of calcium was placed in a brass crucible. (2.) A mixture of pure phosphate of iron, lime, and silica, was placed in a similar crucible. The two crucibles were heated to the temperature of the fusion of steel. The crucible containing the silica was eaten into, and the button of iron, crystallized in large plates, broke with great ease. The crucible containing the fluoride, on the contrary, was scarcely attacked; the metallic button slightly flattened under the hammer, and finally broke, yielding a granular fracture. The first button contained three times the amount of phosphorus present in the second. When operating upon phosphatic minerals containing less phosphorus than pure phosphate of iron, a sensible improvement follows the substitution of fluoride of calcium for silica; nevertheless the improvement becomes less and less important as the quantity of phosphorus in the ore decreases. Other compounds besides the phosphates are soluble in fused fluoride of calcium without decomposition; sulphates, arsenates, &c., behave quite similarly; alumina and analogous substances dissolve in this flux, and can thus be removed in the slag; otherwise the intervention of silica would be necessary.

M. Bauernfeind has published in the *Comptes Rendus* of the Academy of Sciences of Munich some interesting facts with regard to a prism which deviates the incident ray by a constant quantity, whatever be the angle of incidence. This result is obtained by two interior reflections; it is, however, necessary that the first refraction angle of the prism be double that of the second. Designate by A, B, C, the three angles of the prism, and by a, b, c , the three opposite faces; the ray enters at the face a , it is reflected internally first on b , then on c , and passes out at the face b . For the deviation to be constant it is necessary that $C=2A$. A prism satisfying this condition deviates the incident ray by a quantity equal to the first refraction angle C, and the angle of emergence is always equal to the angle of incidence. The intensity may be augmented by silvering the reflecting surfaces. If the edge B be cut in such way as to make a fourth face parallel to b , an object in the direction of the deviated ray may be seen through the two parallel faces. When $C=120^\circ$ and $A=60^\circ$, the angle B becomes zero, and the face a parallel to c .

A rectangular prism, in which $C=90^\circ$, $A=B=45^\circ$, was employed by M. Bauernfeind some years ago in the construction of certain surveying instruments. In an apparatus with crossed prisms, the two prisms being symmetrically superposed, one was enabled to sight at the same time two points situated on the right and left of the observer, and to determine thus a point of the straight line which would join them.

PARIS, MAY 13, 1868.

Sewage of Paris—New process for the manufacture of sulphuric acid.—New method of preparing carbonic acid gas for mineral waters.

THE sewage question is one which has lately attracted considerable attention in Paris; the problem, of course, has been to remove the polluted waters from the town in the most advantageous manner. The volume of these waters is now 100,000 cubic metres a day, soon it will be double this amount, and in a few years probably 500,000 to 600,000 cubic metres. We have three solutions of the difficulty. The first and most obvious is to carry the sewage into the Seine; this scheme has been well tested already, and the disadvantages seem generally more striking than the advantages. The advocates of a second plan would employ the sewage, which they would first raise by machinery to a considerable height, in the irrigation of the fields. The fertilisation of the sands at the mouth of the Thames by this means is cited in favour of the plan. The third scheme recommends itself as being the most scientific, and it is, perhaps, the best; experiments have been made with this scheme since the commencement of the spring. The sewage waters, collected in large basins, are mixed with a certain amount of sulphate of alumina—about 1 per cent to the cubic metre. Organic matters contained are rapidly precipitated, each cubic metre yielding about 3 kgrms. of solid manure. The decanted fluid, termed clear water, can be employed in the irrigation of soils, upon which it has a very fertilising action; it contains, in fact, small quantities of mineral matters in suspension, a little nitrogenous and organic matter, and the whole of the alkaline salts. The deposit obtained in the clarification is abundant and compact; it contains the whole of the phosphoric acid and nine-tenths of the nitrogenous and organic matter, and the mineral matters dissolved or in suspension; it constitutes an excellent manure, very fertilising, and easily transportable. Towns would thus be considered as manure factories, and it is believed that the value of the manure may be made to defray the expense of supplying the town with pure water.

M. Lardani has devised a new method of manufacturing sulphuric acid. The plan may be sketched as follows:—Sulphurous acid, in the presence of excess of air, is passed into dilute nitric acid, which becoming itself reduced, oxidises the sulphurous acid; the sulphuric acid, being very dense, sinks to the bottom of the reacting vessel; hyponitric acid escapes, and traversing the upper part of the apparatus, enters the regenerator, where, meeting with water and excess of oxygen, it produces nitric acid. The apparatus is composed of a furnace for burning sulphur, a washer or scrubber, a refrigerating apparatus, a reacting vessel, and a regenerator for nitric acid. The furnace in which the sulphur is burnt is traversed by a current of air obtained by a ventilator; this current, while furnishing oxygen, serves to chase out the sulphurous acid, the density of which hinders the rapid replacement of air, and thus the rapidity of combustion. Leaving the furnace, the warm sulphurous acid gas enters the scrubber, where it is freed from volatilised sulphur, and especially from arsenious acid when arsenical pyrites has been employed as the source. From this part of the apparatus the gas, passing through a pipe surrounded by cold water which condenses the water and cools the gas, becomes denser, and descends into a cascade apparatus, through which a current of weak sulphuric acid, still containing nitrous products, is made to flow. The reacting vessel into which the gas passes is com-

posed of two parts: the lower portion contains weak sulphuric acid, upon which rests a thick stratum of nitric acid; the upper portion, separated by stoneware plates, or plates of lead or aluminium pierced with holes, contains pumice-stone saturated with water. The sulphurous acid, mixed with a powerful current of air, plunges into the fuming nitric acid, and the escaping gaseous products traversing the layers of pumice-stone, become exhausted by the time they reach the fifth receiving vessel destined to reoxidise the nitrous compounds.

M. Boudet has read a short report before the Academy of Medicine upon a new process, by means of which M. Ozouf obtains pure carbonic acid for use in the fabrication of mineral waters. At the present time the carbonic acid used in the preparation of these waters is produced by making sulphuric acid act upon marble; the calcareous carbonates, however, contain foreign substances not usually separated in the process, and the sulphuric is not completely separated in the washing. To avoid these defects, M. Ozouf has had recourse to the combustion of coke; he thus prepares pure carbonic acid. M. Boudet described at length the rather complicated apparatus employed, adding that the commission were able to testify to the excellent quality and purity of the products. The process obtained general commendation.

PARIS, MAY 20, 1868.

Crystallisation of Sulphur.—Production of Paracyanogen and its transformation into Cyanogen.—Manufacture of Phosphate of Soda and Fluoride of Sodium.—A Sulphur Shower.

AN interesting experiment has been made by M. Schützenberger upon the crystallisation of sulphur. He filled a matrass of a capacity of 150 or 200 grammes with refined sulphur, commercially pure, so that when fused the liquid occupied the whole of the space below the neck; the upper part of the neck was drawn out into a capillary tube which was twisted several times but left freely open to the atmosphere. The sulphur being melted in a bath of oil heated to 120°, the flask was placed in water heated to 95°. In these conditions, the sulphur remains perfectly fluid for hours, even when occasionally moved and drawn out of the hot water. If the temperature be made to fall very slowly, transparent crystals possessing the same density as the melted sulphur form either on the surface or in the midst of the fluid at about 90°. The mass of crystals gradually augments, but with great slowness; sometimes they are isolated, at others united in groups of two, three, four, &c. The amount of crystals being considered sufficient to separate them, the matrass is sharply inverted, so as to cool and solidify the melted sulphur in the neck. Thus the crystals are separated from the rest of the sulphur, and only remain suspended by their peaks. They are transparent and remain so indefinitely; in form they are octahedral and bear close resemblance to natural crystals. Measurement of the angles has confirmed their identity. The experiment is surer when two or three drops of sulphide of carbon are added to the sulphur before fusion; the phenomenon takes place, however, independently of this admixture. The results are similar to those of M. Pasteur, who observed the formation in a solution of sulphur in a hydrocarbon, first of prismatic crystals, afterwards, when the temperature was sufficiently low, of octahedra. By this experiment of M. Schützenberger's it is proved that melted sulphur crystallises below 100° in octahedra of the fourth system without the aid of any solvent. The facts will probably be turned to account in the study of the formation of natural crystals.

MM. Troost and Hautefeuille contributed a memoir at a recent meeting of the Academy, on the production of paracyanogen and its transformation into cyanogen; in undertaking the investigation they considered it interesting to examine whether the relations of cyanogen and its isomer were analogous to those of white phosphorus and amorphous phosphorus. In the present memoir they consider the transformation of cyanogen, free or in combination, into paracyanogen. An examination of the action of heat upon cyanide of mercury

has shown that the proportion of paracyanogen formed is influenced equally by the temperature at which the decomposition of the cyanide is effected, and by the pressure exerted by the cyanogen upon the decomposing salt. A number of experiments were made in sealed tubes placed in various heated fluids; one indispensable precaution to be attended to in making these experiments, MM. Troost and Hautefeuille have found to be the equal heating of the tube at all points, otherwise a portion of the cyanide of mercury escapes decomposition, apparently volatilising, and condenses upon the cool portions in colourless crystals belonging to the system of the right prism with square base. This experiment confirms the observations of M. Des Cloizeaux. A table giving the results of experiments shows the advantage, in regard to the yield of paracyanogen, of the decomposition being made at a low temperature and under strong pressure.

According to Thaulow, cyanide of silver, under the influence of heat, yields half its cyanogen in the gaseous state, incandescence takes place at the same time, and the other half of the cyanogen becoming paracyanogen remains united to the silver in the form of a paracyanide. MM. Troost and Hautefeuille find that cyanide of silver does not decompose at 350° (boiling mercury), but that the decomposition ensues at a temperature very little higher. Heated gradually to 440° and maintained at this temperature it is decomposed completely without fusion or ignition taking place. The proportion of cyanogen which, under these conditions, passes into the state of paracyanogen is about 17 per cent if made in vacuo; it attains 20 per cent under atmospheric pressure; and in sealed tubes, where the pressure is about 60 atmospheres, it may amount to 64 per cent. Cyanide of silver, slowly heated up to about 600°, under ordinary atmospheric pressure, decomposes without either fusion or ignition, while if the temperature be rapidly elevated, both fusion and ignition take place; in the two cases, more than half the cyanogen is disengaged in the gaseous state; the yield of paracyanogen never exceeds 41 per cent. Operating at the same temperature in closed vessels, 76 per cent is obtained. The experiments of MM. Troost and Hautefeuille exclude altogether the idea of the paracyanogen remaining combined with the silver as paracyanide; the paracyanogen is simply disseminated in the silver, and may be separated by mercury. Paracyanogen is most easily prepared from cyanide of mercury; quantities of 5 grammes are placed in strong glass tubes of about 10 centimetres capacity; the tubes being sealed, they are heated to 440° (boiling sulphur). To separate the paracyanogen from mercury, which is intermixed, the tube opened at both ends is heated again to 440° in a current of cyanogen gas. This mode of purification is preferable to the heating to dull redness with sulphuric acid.

A note on the manufacture of phosphate of soda and fluoride of sodium has been published by M. Jean. The process usually adopted in the fabrication of neutral phosphate of soda consists in attacking the tribasic phosphate of lime, either in the form of nodules or calcined bones, with sulphuric acid; thus a solution of acid phosphate of lime containing some sulphate and excess of sulphuric acid is obtained. This solution of acid phosphate of lime is treated with carbonate of soda, when phosphate of soda and carbonate of lime result, but a large quantity of sulphate of soda, or otherwise of sulphate of lime, and free sulphuric acid, requires separating; repeated and carefully conducted crystallizations are therefore necessary. M. Jean made experiments with a view of founding a better process.

The following are notes of experiments:—(1.) In fusing a mixture of one equivalent of tribasic phosphate of lime, two equivalents of sulphate of soda and carbon in excess, and extracting with cold water, a strongly sulphurous liquor containing phosphate of soda was obtained. The residue, chiefly oxy-sulphide of calcium, contained about two-thirds of the phosphate of calcium unattacked. (2.) A second experiment made with three equivalents of sulphate gave soluble acid phosphate 14 per cent; acid in an insoluble form 13.71 per cent; with three equivalents, then, about half the phosphate is obtained in the form of neutral phosphate of soda. (3.) By in-

creasing the amount of sulphate to six equivalents, 20.6 per cent was the yield of soluble phosphate, while the residue contained 1.933 per cent of acid combined with lime. M. Jean attributes this small quantity of phosphoric acid to the action of caustic lime, always present to a slight extent in the residue, upon the phosphate of soda after lixiviation. The decomposition of the tribasic phosphate of lime into neutral phosphate of soda may then be considered complete. Unfortunately the phosphate obtained in this process is mixed with a large proportion of sulphide of sodium, rendering the separation by crystallisation very difficult, and consequently destroying the industrial value of the process. The reaction has given better results in the preparation of fluoride of sodium. A mixture of 40 parts of fluoride of calcium, 80 of sulphate of soda and carbon in excess, was fused in a metal crucible. The mass exhausted with water gave a solution containing sulphide and fluoride of sodium; only a trace of hydrofluoric acid was detected in the residue, composed as before of oxysulphide of calcium. Another fusion was made in which carbonate of lime was added to endeavour to remove the soluble sulphur compounds. The mixture was made of 100 parts of fluoride of calcium, 140 of carbonate of lime, 200 of sulphate of soda and carbon. In treating the mass with water a limpid solution of fluoride of sodium was obtained quite free from sulphide. Traces of hydrofluoric acid were detected in the residue. By concentration and crystallisation, fluoride of sodium in great purity is obtained. Should the application of this salt at any time become important, this process will enable fluoride of sodium to be manufactured in large quantity and at a low price.

The "*Messenger de Toulouse*" records an interesting phenomenon which occurred at Toulouse a few evenings ago, called by the people a rain of sulphur. The earth was covered with a yellow powder bearing great resemblance to pulverised sulphur. The powder was composed of the pollen of flowers borne by a strong wind from the pine forests.

PARIS, MAY 27, 1868.

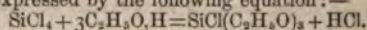
A case in medico-legal chemistry.—Employment of sulphocyanides in toning and fixing photographs.—Derivatives of the radical silico-allyl.

A CASE in medico-legal chemistry, tried at Versailles, is worthy of some attention. Lucifer matches, it was said, had been used in poisoning the victim. The chemist stated that after a scrupulous examination of the exhumed matter (interred two years) he had failed to detect phosphorus, probably volatilised or oxidised long ago, but he had separated several pieces of melted sulphur, which he exhibited. From these facts he concluded that chemical matches must have been present, for these traces of sulphur, though very small, could not occur in culinary or pharmaceutical preparations. The question was then put—did he not know that sulphur similar to that which he had exhibited was found in deposits of fecal matter which had undergone a certain fermentation in the air? and upon this point, the finding of sulphur perfectly crystallised or in concreted masses in the old deposits in the sewer of Montfaucon, was cited; the specimens of sulphur here referred to are preserved in one of the public museums. Great doubt was thus thrown upon the source of the sulphur; indeed, judging from the chemist's evidence, he would appear to have argued farther than the experimental data justified him in doing. The prisoner was acquitted.

At a meeting of the Société de Photographie, M. Civiale made some observations upon the employment of sulphocyanides in toning and fixing. He stated that in the summer of 1867 he fixed about 700 positive proofs by means of potassium and ammonium sulphocyanides. A print, one half of which had been protected from the light, the other unprotected, and which had been exposed for three months, showed only an uniform tint.

MM. Friedel and Ladenburg communicated recently a paper, "on some derivatives of the radical silico-allyl," to the Academy of Sciences. The formation upon heating 3

molecules of silicic ether and 1 molecule of chloride of silicon, to 150°, during an hour, of a product named by MM. Friedel and Crafts, monochlorhydrine silicic-ethyl, and containing $\text{SiCl}(\text{C}_2\text{H}_5\text{O})_2$, has already been pointed out. The same body can be obtained easily, in addition, drop by drop, 3 molecules of absolute alcohol to 1 of chloride of silicon, submitting the product to fractional distillation, and collecting that which distils at about 156°. The reaction taking place is expressed by the following equation:—



A very advantageous yield is thus obtained. Monochlorhydrine silicic-ethyl does not react upon zinc-ethyl, even upon boiling; but the addition to the mixture of a few fragments of sodium, with the aid of a gentle heat, commences a reaction which, if not moderated, may become very energetic. There is produced an abundant disengagement of gas; at the commencement of the reaction this gas is principally composed of chloride of ethyl, afterwards the chlorine disappears, and the gases are simply hydrocarbons (ethyl and hydride of ethyl). The sodium becomes covered with zinc in powder, and finally disappears; the liquid then contains zinc and chloride of sodium. The disengagement of gas having ceased, the operation is arrested, and the product distilled. The major part passes over, after several fractionations, between 159 and 162° when only 1 molecule of zinc-ethyl has been used for 2 molecules of monochlorhydrine. Analysis assigns to this body the formula $\text{SiO}_2\text{H}_2(\text{C}_2\text{H}_5\text{O})_2$, which is confirmed by the number found for the vapour density; experiment gave 6.92, while theory requires 6.65. The density has been found to be 0.9207 at 0°. Evidently in monochlorhydrine, 1 atom of chlorine has been replaced by the group C_2H_5 . The body thus produced is an ethereal liquid, possessing an agreeable odour, resembling that of silicic ether. It is insoluble in water, but soluble in alcohol and ether in all proportions. Moisture transforms it gradually into alcohol, and products boiling at a higher temperature, which are doubtless, say the authors, polysilicates analogous to those which silicic ether gives. Ammonia and even alcoholic potash do not effect complete decomposition; the body partakes of the stable nature of silicon-ethyl, and is only oxidised by nitric acid above 200°. Concentrated sulphuric acid decomposes it instantaneously. With very concentrated hot potash a lively reaction is produced, and the ether is decomposed rapidly, two layers being formed, both soluble in water, which only separates some oily globules. When the solution is neutralised by hydrochloric acid, or better with chloride of ammonium, a white flocculent precipitate is produced, resembling silica. This precipitate collected on a filter and dried over sulphuric acid, burns and blackens when heated on platinum foil; it is soluble in potash and reprecipitated by hydrochloric acid. The solution feebly alkaline gives with nitrate of silver a precipitate white or yellowish soluble in ammonia, and containing a silico-carbonated acid with oxide of silver. By making a combustion of the acid in a current of oxygen, numbers were found leading to the formula $\text{SiC}_2\text{H}_5\text{O}_2\text{H}$ with a small quantity of silica; the body has not yet been obtained in a state of absolute purity. Potash has then split up the ether afresh according to the equation $\text{SiC}_2\text{H}_5(\text{C}_2\text{H}_5\text{O})_2 + 2\text{H}_2\text{O} = \text{SiC}_2\text{H}_5\text{O}_2\text{H} + 3\text{C}_2\text{H}_5\text{O}$. The new ether has received the name of tribasic silicopropionic ether.

REPORTS OF SOCIETIES.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

MICROSCOPICAL AND NATURAL HISTORY SECTION.

February 24th, 1868.

J. B. DANCER, F. R. A. S., *President of the Section, in the Chair.*

MR. SIDEBOTHAM sent two beautifully finished water-colour drawings, accompanied by the following note:—

"I send you a couple of drawings of the dry-rot fungus *Merulius lacrymans*, remarkably fine. Mr. Lynde, our treasurer, brought me the specimens, which he had met with during the demolition of some old buildings. The drawings are of the natural size. It is very rarely that such perfect specimens are found, showing, as this one does, the curious structure of the species, and its connection with both the pore and the gill-bearing divisions of fungi."

Mr. DANCER exhibited some sand from the sea-shore at Santos, South America. This sand was remarkably silvery in appearance, a large portion of it consisting of minute plates of mica, and very transparent fragments of quartz, which made it an interesting object for the polariscope. It was rich also in Foraminifera, spines of *Spatangus*, and fragments of Coralline.

"Remarks on Molecular Activity as shown under the Microscope." By J. B. DANCER, F.R.A.S.

The author stated that, during the last 30 years, he had met with many microscopical observers who were not acquainted with the phenomenon, to which the name of molecular action has been given. This class of microscopists had confined their attention to objects requiring a very moderate amount of magnifying power, and generally to dry objects; but when their investigations extended to minute objects immersed in fluid which required powers of 800 to 1500 diameters, they were startled by the appearance of particles in active motion, not moving in a direct line, but vibrating as if attracted and then repelled by each other, some single, and others in clusters.

Many instances have come under the author's notice, in which these objects have been regarded by microscopists as animalcules. They have given rise to many very ingenious speculations, some of which are connected with spontaneous generation. These observers would have been saved much labour if they had been acquainted with the experiments of the late Dr. Robert Brown on active molecules.

The author does not imagine that the members of this section are wholly unacquainted with the experiments of the early microscopists on this subject, but in the absence of more important matter, he thinks a brief account of the early observations on these so-called active molecules may interest them.

The moving particles had been noticed by Leewenhock, Stephen Gray, Buffon, and others who supposed them to be animated matter.

In the year 1827, the late Dr. Robert Brown, whilst engaged in the microscopical investigation of unimpregnated ovulum, noticed that the pollen of the *clarkia pulchella* was filled with particles, which appeared in active motion when immersed in water. These observations were followed by the examination of the pollen of other plants, the particles of which he found to exhibit similar activity. For some time he was exceedingly perplexed with these phenomena, and was disposed to believe that he had really seen in these minute bodies the supposed constituents or elementary molecules of organic bodies, first so considered by Buffon, Wrisberg, Müller, and Milne Edwards, and on examining various animal and vegetable tissues, whether living or dead, he found as he had expected, that active molecules were visible by merely bruising the substances in water.

Continuing his observations, he found that particles from a bruised specimen of fossil wood appeared to consist entirely of these moving bodies. From this he inferred that these molecules were not limited to organic bodies, or even to their products.

After this he proceeded to examine minerals, simple earths, metals, and many other substances too numerous to mention and with similar results.

Some writers who commented on these experiments, but who had not carefully followed his communications, asserted that Dr. Brown imagined these particles to be animated, and this statement was generally believed.

In 1829 the author's late father repeated many of Dr. Brown's experiments, and to prove that these moving particles could not be animalcules, he placed some crystals and minerals in a crucible which he subjected to a red-heat, ground portions of them to powder, then put it into distilled water, and showed the particles in motion to his scientific friends. It is now well known that all kinds of matter, if reduced to sufficiently small particles, and placed in a medium in which they will not readily sink, will exhibit these movements.

Now, as this phenomenon occurs in the cells of plants, the yolk of the egg, and in decomposing animal and vegetable matter, it is not surprising that the early microscopists, and, indeed, modern ones, should have mistaken them for animalcules. The particles which exhibit the greatest activity are exceedingly minute, ranging from 10,000th to 30,000th of an inch in diameter; they remain active a considerable time if they are nearly of the same specific gravity as the solution in which they are immersed. One simple mode of producing them is to rub a little gamboge in water, on a glass slide, and place a thin glass cover on it, using a power of from 800 to 1,200 diameters. They can easily be distinguished with less magnifying power, but are not so effectually shown. If they are required for prolonged examination, Dr. Brown recommends that the solution of gamboge be mixed with a little almond oil. The minute globules of water are thus surrounded by oil, and rapid evaporation is prevented.

The cause of the phenomenon is not yet satisfactorily accounted for. Some have imagined that it is the physical repulsion of the particles when uninfluenced by gravitation. The author has tried many experiments with electricity and magnetism without success. He thinks that the movement may possibly be connected with the absorption and radiation of heat.

Those interested in Dr. Brown's experiments and observations on active molecules, can refer to his republished papers in Vol. I. of the Ray Society's publications for 1866.

After the meeting, slides containing active molecules were exhibited to the members.

A conversation took place on the preservation of dried plants, in which Mr. Bailey stated that he uses with success glue with carbolic acid for attaching them to the paper, as a preservation against mites, placing also a few crystals of the dry acid in his cabinet.

Ordinary Meeting, April 14th, 1868.

R. ANGUS SMITH, Ph.D., F.R.S., Vice-President, in the Chair.

Mr. WM. BROCKBANK and Mr. A. BROTHER were appointed Auditors of the Treasurer's accounts.

Mr. S. BROUGHTON said that, on recently observing with high powers a group of fine spots on the sun, one of which was of considerable magnitude, it occurred to him to remove the dark glass, and by keeping the eye much beyond the focus of the heating rays, and at such a distance that the spot almost filled the apparent field of the eye-piece, to see if any phenomena could be observed different from those seen through the dark glass.

The spot was at once seen to be of a dark blood red; but thinking this perhaps might be from the strong contrast of colour, he attached a disc of plaster of Paris to the telescope, and projected the image of the spot on it. On looking at this with a common pocket magnifier, the image was observed to be a dark blood red, although the observatory was not darkened, and the disc merely shielded from the direct rays by an intervening opaque substance.

If these observations are confirmed, it will corroborate the opinion long held that the spots are not black, but appear so by contrast, and, as it would seem, from the intervention of the coloured glass.

ACADEMY OF SCIENCES.

PARIS, APRIL 13th, 1863.

*Formula of molybdic acid and equivalent of molybdenum.—
Production of paracyanogen and transformation into cyanogen.*

At the meeting of the Academy, on the 13th of April, the following memoirs were contributed:—"On the formula of molybdic acid, and on the equivalent of molybdenum," by M. Debray; "On the production of paracyanogen and its transformation into cyanogen," by MM. Troost and Hautefeuille. "The employment of fluoride of calcium for the smelting of phosphide of iron minerals," by M. Caron; "On the crystallisation of sulphur," by M. Schützenberger; from whom there was another memoir, entitled "On some reactions giving place to the formation of oxychloride of carbon;" "On the amides of sulphoxyphosphoric acid," by M. Chevrier; "An addendum, by M. Lecoq de Boisbaudran, to his previous communications upon the supersaturation of saline solutions," completes the list of papers of chemical interest.

It is almost superfluous to say that M. Debray's memoir is one of interest. M. Debray prepared chloride of molybdenum by the direct action of chlorine on the metal gently heated; the product, distilled in a current of dry carbonic acid (to eliminate excess of chlorine), has a deep green colour; it melts at 194° , and boils at 268° . The mode of preparation is similar, and the majority of the characters of this substance agree with a chloride of molybdenum to which Berzelius and others have attributed the formula MCl_2 . In all probability this formula was given to the chloride in consequence of the solution, precipitated by ammonia, yielding an abundant precipitate of hydrated bioxide of molybdenum; but the presence still of a large quantity of molybdic acid in the filtered liquor is easily demonstrated. Further, three analyses of this substance have given 35 to 35.2 per cent of molybdenum: the formula M_2Cl_3 requires exactly 35 per cent of metal, while the formula MCl_2 requires rather more than 40 per cent. M. Dumas has accorded to molybdenum, in his work on the equivalents, the number 48. More recently, M. Delafontaine and M. Ullik have, notwithstanding, used the number 46 throughout their researches on the molybdates; M. Rammelsberg also found 46, in reducing molybdic acid by hydrogen, and this number is generally admitted in Germany. M. Debray's results confirm those of M. Dumas. He prepared pure molybdic acid by subliming it in a platinum tube; the sublimation cannot be effected in a porcelain tube, since molybdic acid easily attacks porcelain at the temperature of sublimation. The sublimed acid is extremely bulky, and to enable operations to be made upon a considerable scale it was necessary to transform the acid into molybdate of ammonia: this salt gives by careful calcination an acid both dense and free from lower oxides. The transformation of the acid, which is volatile, into fixed red oxide is effected by heating in a current of hydrogen at the lowest possible temperature; this reduction is made in a glass tube. Under these circumstances a little matter is carried out from the boat, and forms a red ring upon the sides of the tube. This amount of substance is appreciable; it must be carefully withdrawn, and treated successively with nitric acid and ammonia, and the weight determined. The final reduction is effected in a tube of unglazed porcelain, at a very high temperature. As molybdenum attacks the porcelain wherever there is contact, a platinum boat is used, and this prevented from touching the tube by a small piece of platinum foil. Finally, it is necessary to avoid the use of corks and everything capable of furnishing gaseous carbides. The hydrogen is purified by passing over a long column of copper maintained at a red-heat during the whole time the experiment lasts; it is afterwards dried with fused potash. The porcelain tube M. Debray makes use of is long and furnished with a narrow tubulure, serving to convey the hydrogen. The equivalent deduced from the amount of metal obtained from a given weight of molybdic acid was in one experiment 48.03 , in another 48.04 , and in a third 47.84 . The smallness of the third number is

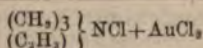
explained by experimental errors. The synthesis of crystallised molybdate of silver enabled these results to be verified. In evaporating slowly in a dark oven, a strongly ammoniacal solution of molybdic acid and nitrate of silver, small, regular octahedral crystals of molybdate of silver were obtained. This solution was found to contain a little more silver than that required by the hypothesis $M = 46$, $MO_3 = 70$. By gently evaporating to dryness, and dissolving out the excess of nitrate of silver, the weight of silver not precipitated by the molybdic acid was easily arrived at by precipitating as chloride. The results thus obtained showed $M = 48$, and $M = 47.98$. The molybdate of silver was of course free from ammonia.

PARIS, APRIL 20th, 1863.

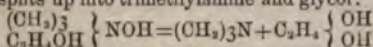
*Theory of electro-capillary phenomena.—Identity of artificial
with natural nevrine.—New calorimeter for rapid combustions.—Laws of the transformation of paracyanogen into
cyanogen.*

At the séance of the 20th of April, the following memoirs were communicated to the Academy:—"On the theory of electro-capillary phenomena, comprising endosmose, exosmose, and dialysis," by M. Bequerel; "On the identity of artificial nevrine with natural nevrine," by M. Wurtz; "A new calorimeter for rapid combustions," by M. Favre; "Laws regarding the transformation of paracyanogen into cyanogen, and the inverse transformation," by MM. Troost and Hautefeuille; "Note on the preparation of the salts of sesquioxide of iron, and on ferric chloroxide (Fe_2Cl_3 , Fe_2O_3 , + Aq)," by M. Jeannel; "Note on the manufacture of phosphate of soda and fluoride of sodium;" "On a new acetate of chromium," by M. Schützenberger; and "On some derivatives of the radical silico-allyl." The number of papers of chemical interest is seen to be unusually large; an account of M. Wurtz's synthesis of nevrine having already appeared in this journal, an abstract of his present memoir will, doubtless, be read with interest.

M. Wurtz has obtained the chloride of nevrine extracted from the brain and the chloride of the artificial nevrine in long deliquescent needles, by dissolving the dry salt in absolute alcohol, and cautiously pouring on to the surface of the moderately concentrated solution anhydrous ether. The natural chloride of nevrine was separated from the auro-chloride by sulphuretted hydrogen, the solution filtered from sulphide of gold being evaporated, first on the water-bath, then in vacuo. The chloroplatinate of trimethyl-oxethylammonium is very soluble in water, but insoluble in alcohol. When the precipitate produced by alcohol in the aqueous solution is redissolved in water, and the solution allowed to evaporate spontaneously, magnificent clinorhombic prisms, of an orange-red colour, are obtained; crystals of regular and considerable dimensions may be obtained. Among the properties of chloride of nevrine which have been pointed out by M. Bayer, one of the most characteristic is its reduction by hydriodic acid. The oxethylic base is converted in this case into an iodethylic base. The iodide of trimethyliodethylammonium thus formed is little soluble in cold water, and is deposited in fine crystals from the boiling aqueous solution. M. Wurtz obtained abundance of this substance by reducing artificial chloride of nevrine by hydriodic acid in presence of phosphorus, at a temperature of 140° . By ebullition with water and oxide of silver, this iodide of the iodethylic base is converted into the hydrate of the corresponding vinylic base. M. Wurtz has performed this experiment upon the iodide made with artificial nevrine; M. Bayer indicated this reaction for natural nevrine. In saturating with hydrochloric acid, the hydrate resulting from the action of oxide of silver upon this iodide, and adding chloride of gold, M. Wurtz has obtained a yellow precipitate, soluble in boiling water, and depositing, upon cooling, small crystals, which have the composition of auro-chloride of trimethylvinylammonium:—



The dilute solution of hydrate of trimethyloxethylammonium (free nevrine) may be boiled without undergoing sensible decomposition; but this is not the case with concentrated solutions; they disengage trimethylamine, a reaction already indicated for natural nevrine. This is not the only product of the decomposition. When a flask, in which the solution has been completely evaporated, and in which nevrine no longer remains, is allowed to cool, a small quantity of a thick, slightly brown liquid is condensed. This body only boils at an elevated temperature; a small quantity boiling above 190° , collected, presented the characters of glycol. Heated with dry potash this body liberated, in fact, pure hydrogen; nitric acid vividly oxidised it. The formation is easily understood; hydrate of trimethyloxethylammonium, under the influence of heat, splits up into trimethylamine and glycol:



This reaction affords the first example of the formation of glycol at the expense of a natural substance.

PARIS, APRIL 27th, 1868.

Association of the Incandescence of Magnesia to that of the Carbons in the voltaic arc.

THE meeting of the Academy held on the 27th of April requires little space. The only two memoirs of chemical interest were, the preparation of magnesia as a refractory substance, by M. Caron, already translated in full; and the association of the incandescence of magnesia to that of the carbons in the voltaic arc, by M. Le Roux. By placing the base of a cylinder of magnesia about eight millimetres in diameter at a little distance from the carbon points, so that the arc may just touch it, the magnesia acquires a degree of incandescence comparable to that part in the bordering carbon craters. At the same time the light acquires a remarkable degree of constancy.

PHILOSOPHICAL SOCIETY OF GLASGOW.

Ordinary Meeting, April 29th, 1868.

Dr. F. H. THOMPSON, President, in the Chair.

AMONGST the papers read at this meeting, there was one "On the Sources of Sulphur used in the Manufacture of Oil of Vitriol or Sulphuric Acid," by Mr. JAMES MACTEAR, F.C.S., of the alkali department, St. Rollox Chemical Works. After making some few preliminary remarks,

Mr. MACTEAR proceeded to say that the quantity of oil of vitriol manufactured in this country exceeds 500,000 tons per annum, and of this quantity about 320,000 tons are used in the conversion of common salt into sulphate of soda, for the production of alkali by Leblanc's process, the remainder being taken up chiefly in the manufacture of artificial manures. The sulphur consumed last year, in making oil of vitriol, amounted to 160,000 tons, but of this quantity only from 10,000 to 20,000 tons consisted of brimstone; the remainder is obtained from pyrites, of which upwards of 375,000 tons were burned. The brimstone is used chiefly in the manufacture of "sulfuric acid," and this again is used mostly for bleaching purposes which require a very pure acid, that made from pyrites being always more or less contaminated with arsenic and other impurities of a detrimental character.

Since the year 1851 the price of brimstone has been very high, owing to the great quantity of sulphur required in the treatment of the vine disease.

Up to the year 1856 all the pyrites used was obtained from Cornwall and Ireland, except a small quantity of "coal brasses" found in the coal fields. In that year some cargoes of Spanish pyrites, containing a small percentage of copper, were imported and used by the Tyne manufacturers, who liked the ore very much, on account of the high percentage of sulphur which it contained; while it is burned at as low a

cost per ton as the ore of low strength. At least one half of the ore now used is Spanish cupriferous pyrites. The author illustrated the economy of working pyrites by stating that Irish ore contains about 35 per cent of sulphur, while Spanish ore contains as much as from 45 to 50 per cent; and, assuming that the cost of burning in both cases is 2s. per ton, in the one case 35 parts, and in the other from 45 to 50, are burned off for the same amount. But it is found that the refuse contains, in both cases, about 5 per cent of sulphur on the average, so that there is actually burned off 86 per cent of the sulphur of the Irish ore, and 89 per cent of that contained in Spanish ore of 45 per cent strength, thus giving a clear gain of 3 per cent.

Mr. MACTEAR then referred to certain disadvantages attending the use of pyrites instead of Sicilian sulphur:—

First. A greater amount of chamber space is required for burning pyrites than for sulphur. This is usually taken to be in the ratio of 45 to 30, and is due to the fact that the iron of the ore is peroxidised during combustion, and therefore uses extra oxygen and nitrogen (which passes on unchanged); and for the extra amount of both of these gases chamber space must be provided.

Second. The arrangements for burning pyrites are much more costly than for burning sulphur; the heat is greater, and therefore there is more wear and tear of the chamber and connecting-pipes.

Third. There is always a larger percentage of nitre required with pyrites than with brimstone.

Fourth. Owing to various causes, the acid produced is of inferior quality.

Fifth. It involves more labour to work pyrites than to work brimstone; and there is a large amount of refuse—approximately three-fourths of the weight of the raw ore—for which room has to be provided.

Sixth. In burning pyrites, and during transit, much small is made, and this cannot be burned properly unless in a separate furnace. The most common form is a muffle furnace; in it the "smalls" are roasted, with free admission of air, but the quantity passed into the chamber is so great, in proportion to the sulphur, that this method is objectionable.

Taking all these disadvantages into account, it is found that, in making ordinary sulphuric acid, 1 ton of sulphur, in the form of pyrites, costs only £4 10s., while Sicilian sulphur costs from £6 to £7. The ore is usually sold at so much per cent of sulphur per ton; for some years the rate was 18. per unit, at present it is 8d.

Theoretically, 100 parts of pure sulphur should yield 306.25 parts of oil of vitriol, and in practice it is found that 100 parts of brimstone, containing one per cent of impurity, can be made to yield 302 parts of acid, while with pyrites the acid produced only amounts to 285 parts of the sulphur actually burned, or 275 parts of the sulphur actually present in the ore.

The author then referred in detail to the several sources from which the required sulphur is obtained. He spoke of them in the following order, and illustrated his remarks by a very extensive collection of specimens:—

Sicilian Sulphur.—This is found chiefly in the volcanic districts on the south coast of Sicily, more or less pure, and imbedded in lime and clay marl. It is extracted from the crude mineral in various ways, according to the richness of the material. If the mineral is very rich, it is simply melted in a cast-iron pot, and then the liquid sulphur is ladled out into moulds; but if the mineral is poor in sulphur—some kinds containing only 15 to 20 per cent—it is distilled in earthen retorts, and usually condensed in water. As imported into this country it consists of three qualities—"firsts," "seconds," and "thirds." The latter only is used for making oil of vitriol, the others are refined for making gunpowder.

Spanish Pyrites.—In the author's opinion, this mineral claims the first attention, owing to its forming at least one half of all the pyrites burnt in the sulphuric acid manufacture. It is found chiefly in the province of Huelva; the

deposits pass, however, from Spain into the adjoining part of Portugal. Some of the deposits are nearly a mile long, of great depth, and of varying width. Till lately, the great bulk of pyrites imported was brought chiefly from Mr. Mason's mines, near the river Gaudiana. The owner was the first person to construct a railway as a means of transport from the mines to the coast, instead of the antiquated and expensive method of mule carriage. Mules are still employed at all the other mines, and the mineral is carried in sacks or baskets on the mules' backs. A few years since, the Tharsis Mining Company, consisting chiefly of Glasgow capitalists, was formed to purchase and work a number of mines. The pyrites from the Tharsis mines are now used largely, and the imports of Mr. Mason's ore have been much reduced. The latter usually contains about 50 per cent of sulphur, besides 3 or 4 per cent of copper. The Tharsis mineral contains 45 to 50 per cent of sulphur, and 4 to 5 per cent of copper. Both kinds are much the same in their working qualities; they burn well, and make comparatively little dust in breaking.

Norwegian Pyrites.—Many mines of pyrites occur in Norway, but those in the vicinity of Drontheim are the most important. The Norwegian ore is pretty largely imported into this country, but chiefly to the Tyne. The largest quantity is raised in the mines Ytteröen, the annual product being from 6,000 to 8,000 tons. It consists of very small crystals, is of good quality, burns well, and does not slag in the kilns. It contains about 44 per cent of sulphur, and from 1 to 2 per cent of copper. Under this head Mr. Mactear referred to a second quality of this mineral; to an excellent variety obtained about 30 miles from Drontheim, and containing but a trace of copper; to the ores obtained from some mines opened lately near Bergen; and to another variety which comes from Nordland, yielding 42 per cent of sulphur.

Swedish Pyrites.—This is obtained in mining for copper ores, and is said to exist in enormous quantities, but at present the want of means of cheap transport to convenient shipping prevents it coming into extensive use. A few cargoes, however, have found their way to Britain, and the ore itself has been found to work.

Belgian Pyrites.—Large quantities of this ore are imported, especially to the Tyne—the freight from Antwerp being very low, sometimes only 6d. per ton. The mines yielding it are in the districts of Liege and Namur, and are worked primarily for lead and zinc ores. One kind is called alluvial pyrites, and has the form of coprolites, and few of the pieces weigh more than a pound each. It burns well if used along with Norwegian or other ores. Another resembles a slag or cinder, and often contains lead or antimony. Belgian ores contain from 40 to 50 per cent of sulphur, and traces of thallium.

Westphalian Pyrites.—This resembles a very poor fire-clay, or shale, in appearance, but it burns well. It is said to contain a considerable quantity of thallium. The analysis gives 42 to 45 per cent of sulphur.

Italian Pyrites.—Very little of this is imported, for although it contains about 45 per cent. of sulphur, it also contains 9 to 10 per cent of silica, and its physical properties are not in its favour.

Irish Pyrites.—This is obtained from the Wicklow mines, where it occurs in beds of great thickness. It contains from 30 to 35 per cent. of sulphur. A deposit occurs in the Vale of Avoca, which contains about 44 per cent of sulphur.

Cornish Pyrites.—Under this head the author included the ore from the mining districts of Dorset, Devon, and Cornwall. It is got in the dressing of the lead and copper ores, and usually contains from 25 to 30 per cent of sulphur and 1 or 2 per cent. of copper, and frequently arsenic. The author also referred to the fact that Mr. Vivian is making sulphuric acid by burning copper pyrites in kilns of peculiar construction.

Coal Brasses.—This material, also called "Scotch gold," is largely used, and is a cheap source of sulphur for acid to be used in making manures, &c. Even when well cleaned it

always contains organic matter, and possesses other disadvantages; still it is useful in keeping up heat in the kilns if used along with other varieties.

Cleveland Pyrites.—Although interesting to the geologist, this mineral is of little interest to chemical manufacturers, and the author said he only knew of one establishment where it is used—one near Middlesbro'-on-Tees.

The author concluded his paper by referring to the sulphur-recovery process, patented by M. Mond, and now being practically applied under his (the author's) care at St. Rollox Chemical Works.

Several members of the Society spoke on topics suggested by the paper; a vote of thanks was passed to Mr. Mactear.

Chemical Section, 4th May, 1868.

ALEXANDER WHITELAW, Esq., *Treasurer, in the Chair.*

At this, the last meeting for the session, a paper was read by Dr. Wallace, F.R.S.E., F.C.S., analytical chemist, on "*The Animal Charcoal used in Sugar Refining.*"

Dr. WALLACE stated that his communication to the Section was not to be dignified by the name of a research, but as his name had been associated with the chemistry of sugar-refining during the last ten years, he thought it likely that as a result of his observations and experiments he might be able to mention some things not contained in books. He stated briefly the mode of making animal charcoal from bones, and mentioned the principal Scottish manufacturers of the substance. All the bone char made in Glasgow, Paisley, and Greenock, in addition to a large quantity imported from France and Russia, is used in the Clyde refineries. A large amount of it is manufactured; for notwithstanding the fact that the charcoal lasts a considerable time, it has to be occasionally renewed, owing to the stock gradually dwindling down from various causes. The author calculates that the quantity of animal charcoal in actual use in the Clyde refineries is probably well nigh 5,000 tons, and that the annual renewal is probably about 1,500 tons.

The carbonisation of the bones is usually continued for twelve hours, that length of time generally giving better charcoal than when the bones are only carbonised for six hours, even though in the latter case the heat is made stronger. After the bones are charred they are crushed between rollers, and the charcoal is ready for use when the dust is removed. The quality of the char varies with the kind of bones employed, and the care observed in the charring operation. Hand-picked home-collected bones make the best charcoal. Besides these there are the shank bones from the *Saladeras* of Brazil and Buenos Ayres; camp bones dug up from old battle fields, and bearing evidence of having been buried for a long time, and the charcoal from which may be easily distinguished from that prepared from home-collected bones; and there are also large shipments from Italy and Turkey, including the bones of the camel along with those of cattle, antelopes, sheep, and horses.

In the analysis of the best charcoal from home-collected bones, carbon usually occurs to the extent of about ten per cent, the remainder being the phosphates and other mineral ingredients of the natural bones. The carbon varies with the amount of grease and gelatin left in the bones after boiling, and it also varies in the different parts of the same bone,—the hard exterior containing less than the extremities and spongy interior of the bone. Charcoal as met with in commerce usually contains about ten per cent of water, as water is used to cool the char as it is drawn from the retorts.

The author then stated generally the method of conducting the analysis. It presents certain difficulties notwithstanding the apparent simplicity of the composition of bone charcoal. He instanced carbonic acid as offering some difficulty, and said that his own method of estimating it was less complicated than the one given by Fresenius, although the latter is otherwise equally good. The method used by some chemists of precipitating the phosphate of lime, and then throwing down the lime in the filtrate in the usual way, he

characterised as giving entirely fallacious results. Free lime has been occasionally found by the author, but only in minute quantity. Before estimating the carbonic acid the finely pulverized charcoal should be treated with solution of carbonate of ammonia.

Chemists have long been aware of the presence of nitrogen in animal charcoal, but the custom hitherto has been to include it in the carbon. Dr. Wallace finds it to vary in amount, and to diminish in quantity as the char is used. He found it to be 1.55 per cent. in a total of 8.5 of so-called carbonaceous matter in char made from home-collected bones; and in another sample made from foreign bones it was 1.08 out of 9 parts of carbonaceous matter. Two samples of moderately old charcoal gave respectively .3 and .55, of nitrogen, while the carbon was reported at 15 and 17, respectively. The author did not venture to say whether or not the nitrogen plays any important part in the decolourising action, although, he said, no really good decolourising agent exists that is not made from an animal substance. It is not enough that the charcoal should be porous, for wood charcoal is so, and yet it is practically useless as a decolouriser.

Traces of ammonia always exist in new char, but the amount is so minute that the author has never estimated it. Frequently, however, it exists in the form of sulphide of ammonium, a compound which greatly damages sugar run through it. Such char should be well washed and returned before being used. The washing removes common salt, ammonia, and the sulphide of calcium which is likely to be present if the char has been overburnt. The last-mentioned substance is due to the decomposition of the sulphate of lime, and acts injuriously on the sugar. Sulphuretted hydrogen is also given off from overburnt charcoal when treated with water or acid. A sample of new char gave .08 per cent of sulphuretted hydrogen on treating it with hydrochloric acid. Combustible gases are frequently given off by both old and new char, and sometimes they form explosive mixtures with the air of the cisterns.

Speaking of the mechanical properties of animal charcoal, Dr. Wallace said that he had long regarded the bulk occupied by the char as compared with its weight as a property of great importance. He stated that a ton of new and dry char fills a space of about 48 or 50 cubic feet, while a ton of old char may fill no more space than 40, 35, 30, or even 28 cubic feet, the apparent density of dry charcoal thus becoming sometimes nearly double what it was. But the absolute specific gravity of old and new charcoal varies but very slightly. That the charcoal rapidly diminishes in bulk while the real gravity remains practically unaltered is a point of great importance, and one to which the author thinks he was the first to direct the attention of sugar refiners. The inference is that by frequent re-heating, the particles of charcoal become smaller owing to the diminution of the pores; hence the apparent gravity of char gives a ready and certain indication of its value in sugar refining. From experiments made by Dr. Wallace, a specimen of new char lost as much of its porosity by burning in a covered crucible during eleven hours as it would have lost by re-burning about one hundred times in a sugar-house. He is of opinion that the porosity of the charcoal is diminished by a sort of agglutination of the particles of phosphate of lime during the re-heating. New charcoal will hold from 80 to 100 per cent of water, and is made perceptibly wet with 20 per cent of water, while old charcoal (two or three years in use) will only hold from 30 to 45 per cent, and is made perceptibly wet with only 5 per cent of water. These facts prove that the pores become either smaller or less numerous as the charcoal is used, and point to the conclusion that, to keep animal charcoal in the most efficient state, it should be returned in such a way as to lessen the porosity as little as possible.

Dr. Wallace finds that although the action of heat is the main cause, it is not the only one concerned in producing an increase in the apparent gravity of the charcoal. The

proportion of carbon may increase during use from 8 or 9 per cent to 14, 15, or even 19 per cent,—this increase being derived from the organic impurities in the sugar. The carbon obtained in the carbonisation of these impurities is deposited partly on the surface, but largely also in the pores. This is found to be a great evil, and a great point is gained if it can be prevented. That it can be prevented is proved by the fact that in some refineries the amount of carbon does not increase, while in others it even decreases, but this is owing to mismanagement in the re-heating. When the retorts are quite tight, and the heat not excessive, the carbon necessarily increases if the precaution be not taken to wash well before re-burning, so as to remove all the organic matter absorbed from the sugar liquor. To do this, boiling water is requisite, and one of the most advanced of the Clyde sugar-refiners insists that the charcoal should even be boiled with the water. The author's experience accords with that of the sugar-refiner referred to.

In ordinary cane sugars there is from $\frac{1}{2}$ to 1 per cent of soluble mineral matter, consisting of salts of potash, soda, lime, and magnesia; and in beet sugars there is much more—from $\frac{1}{4}$ to 3 per cent, and sometimes as much as 6 or 7 per cent. The highly soluble salts, such as the salts of potash, do not affect the charcoal, and only annoy the refiner by accumulating in the syrups; but the sulphate of lime is detrimental, owing to its comparative insolubility, and to the fact that it is readily absorbed from the sugar liquor by the charcoal. It may be removed, however, by copious washing and boiling, and it is even removed in solution by washing with weak sugar liquors. Such charcoal is sure to have its sulphate of lime increased if it be washed with water naturally containing that substance in large quantity. The author stated that he had analysed charcoal containing $2\frac{1}{2}$ per cent of the salt, and that the usual amount in old char is from $\frac{1}{2}$ to $\frac{3}{4}$ per cent, but that in extreme cases it may be present in Clyde charcoal to the extent of 1 per cent. The carbonate of lime present in some hard waters is also absorbed by the charcoal.

The author briefly considered the offices fulfilled by the various ingredients of the charcoal. Animal charcoal has great power of absorbing gases, colouring matters, and such mineral salts as are but slightly soluble in water. The removal of colouring matter is the chief object in view; but gummy and other extractive matters have also to be removed. Animal charcoal extracts them both with equal facility. The author finds that it readily absorbs ordinary egg albumen and gum, and he thinks that the circumstance that each of these bodies has an insoluble modification may have something to do with their absorption by the charcoal. Iron is readily removed from sugar liquors by passing them through a cistern of new char. It is the nitrogenous carbon which is the most powerful decolourising ingredient of the char, for if the char be burnt perfectly white, on the surface and without, it does not remove the slightest trace of colouring matter. This fact the author has demonstrated by actual experiment; it is with him no mere opinion.

The highly porous carbon is not the only useful ingredient, although it is essentially the decolourising agent. Carbonate of lime is also of use in neutralising the small proportion of free acid present in almost all sugars except beet; and it is still more important in neutralising the lactic and other acids formed in the weak liquors, by a process of fermentation which it is difficult to prevent. Hence charcoal deprived of its carbonate of lime is objectionable, and its use is certain to produce sour liquors and give rise to the presence of iron in the low-class sugars. As the water of Greenock and Glasgow contains only traces of carbonate of lime, the quantity of that salt naturally present in charcoal gradually lessens, until in pretty old char it is sometimes reduced to about $1\frac{1}{2}$ per cent. In refineries conducted on scientific principles the amount is never suffered to fall so low. If it falls below $2\frac{1}{2}$ per cent, sour liquors are sure to follow. When very hard water is used, the carbonate of

lime either decreases very slightly or it increases, and sometimes even to an alarming extent, as in the continental beet refineries, where the evil is a very serious one.

Dr. Wallace referred to the various methods—especially those of Beanes and Gordon—for getting rid of any excess of carbonate of lime in the charcoal; and then spoke of the inconvenience attending the use of animal charcoal in sugar-refining, owing to its oxidising influence upon the organic matters extracted by the char from the sugar, and to the alteration of the nitrogenous compounds by means of which fermentation is induced, and ultimately organic acids are formed at the expense of the sugar. These acids make the washings sour and putrid, and a necessary and evil result of that is that they decompose sulphide of calcium or sulphide of iron in the charcoal, and dissolve carbonate and sulphate of lime and oxide of iron; then, as the washings are either thrown back amongst the other products of the refinery, or mixed with a fresh lot of raw sugar, they occasionally cause an immense amount of mischief. The author said that, owing to its importance, this department of sugar refining had occupied a good deal of his attention, and he claimed to have made known to refiners the means of entirely preventing such injurious results as those referred to. His method is as follows:—While the liquor is on, the char cisterns are kept at a temperature of at least 150° Fahr., so long as the liquor is strong, to prevent fermentation. Then the water used for washing down the sugar is to run on quite boiling, and this is done with all the washings which are to be preserved. When these directions are attended to, there is no difficulty with sour washings, or with the presence of iron in the low-class sugars. The char should ultimately be washed with boiling water for 10 or 12 hours, or even boiled with it.

The author concluded with a detailed account of the modes of re-burning charcoal, and of the good and bad qualities of the different kinds of re-burners now in use, and suggested the directions in which improvements might be made.

An interesting discussion followed, and various questions were asked and answered in reference to the condition in which the nitrogen exists in the charcoal, and in reference to the use of blood and clay, soot and clay, and gluten charcoal, in sugar refining.

On the motion of the CHAIRMAN, a hearty vote of thanks was accorded to Dr. Wallace.

ROYAL INSTITUTION OF GREAT BRITAIN.

Weekly Evening Meeting, Friday, March 13, 1868.

"On the Probable Exhaustion of our Coal Mines," by W. STANLEY JEVONS, M.A., Professor and Cobden Lecturer on Political Economy in Owens College, Manchester.

I. The coal raised from the coal mines of the United Kingdom in the year 1866, amounted to more than one hundred million tons (more exactly 101,630,544 tons), according to the excellent returns published by Mr. Robert Hunt, of the Mining Record Office. Reflecting upon the full significance of this fact, it may be asserted:—

1. That the coal trade of this kingdom is the greatest trade, in regard to the bulk and weight of the commodity, ever carried on.

2. That every pound of that vast quantity of coal may be regarded as a pound of the most intrinsically useful and valuable substance ever discovered.

3. That the power and usefulness of coal is felt in every branch of industry, and in almost every operation which we carry on.

4. That Britain possesses the aid of this most invaluable substance in an altogether peculiar degree: and—

5. That we cannot hope to stand very long in this most happy position.

II. So vast a quantity as 100,000,000 tons cannot be represented to the eye or mind. Its bulk is 30 times as great

as that of the greatest single work of human hands, the Pyramid of Cheops. Greater quantities of commodities are brought into British ports at present, than are recorded in the history of any nation, and yet it would take more than seven times as many vessels as those which enter our ports in a year to carry the quantity of coal we use.

More than half of the whole carrying power of the railways of the United Kingdom, devoted to goods traffic, is occupied in the conveyance of coal. So far as we can judge from returns, which do not always distinguish the kind of goods carried, the goods traffic of the railways of the United Kingdom in 1865 was as follows:—

	TONS.
General Merchandise*	36,800,000
Minerals	18,300,000
Total	55,100,000
Coal and Coke	59,500,000
Total	114,600,000

III. This vast trade in coal can only be accounted for by considering the wonderful qualities with which coal is endowed. It is the mainspring of our material industry. It may be called the real Philosopher's Stone, which supplies us cheaply and plentifully with everything that can conduce to the service of man. This extreme usefulness of coal is due—

1. To the enormous power which is latent in it, and is brought forth when we burn it;

2. To the fact, now so clearly revealed by science, that force is the key to all the changes of matter.

By aid of the mechanical equivalent of heat, we can ascertain that good coal contains latent force sufficient to raise its own weight 11,422,000 feet, or about 2100 miles against the force of gravity. The coal raised in 1866 may further be calculated to contain force equal to that which would be exerted by 530,000,000 horses, or 2,650,000,000 men, working eight hours a day for 300 working days in the year.

IV. This vast power is turned to use in an indefinite multitude of ways, which may thus be rudely classified.

CLASSIFICATION OF THE USES OF COAL.

(1.) AS SOURCE OF HEAT.

1. For Household Use.—Warming and ventilating houses, churches, public buildings, &c.

2. For the Alteration of Cohesive Condition of Substances.—Melting and casting of metals; softening and forging of metals—the blacksmith's fire. Manufacture of glass, bricks, earthenware, &c.

Boiling salt, soap, &c.; brewing distilling; drying substances.

Chemical manufactures.

3. For the Production of Power by the Steam, Gas, or Hot-air Engine. Pumping water; draining mines; supply of water; removal of sewage.

Steam navigation.

Railways, and road locomotives.

Hammering, rolling, and working metals.

Mill and factory labour.

Hydraulic and pneumatic machines.

Small machines moved by gas-engine.

Machine agriculture; steam ploughing, &c.

Manufacture of ice.

(II.) AS REDUCING AGENT; SOURCE OF HEAT, WITH CHEMICAL AFFINITY.

Smelting of the metals—iron, copper, lead, zinc, &c.

Chemical manufactures.

(III.) AS INDIRECT SOURCE OF ELECTRICITY BY MAGNETO-ELECTRIC MACHINES.

Electro telegraphy.

Electro-metallurgy.

(IV.) AS SOURCE OF LIGHT.

Gas manufacture; petroleum; paraffin candles.

* Not including live stock, of which the weight is not ascertained.

Electric light-house illumination.

Photography by artificial light.

(V.) AS SOURCE OF MATERIAL.

Tar, pitch, naphtha, lubricating oils.

Ammoniacal manures: carbolic acid; aniline dyes; ethereal odours and flavours, &c.

It is only by thus collecting together the multitudinous uses of coal that we can gain an adequate idea of its importance to us and the certainty that its use will extend.

V. Comparing, now, the present yield of coal (100,000,000 tons annually) with the quantity which Mr. Hull believes to lie in these islands, within 4000 feet of the surface and in workable condition (83,544,000,000 tons), we find that we might continue to consume coal at our present annual rate for 835 years at least; but when we remember that our consumption has increased by 36 millions in the last twelve years (from about 65 millions in 1854 to 101,000,000 in 1866), and that the causes of increase still continue in existence, we cannot attribute any importance to the above calculation. There is no appearance that steam navigation or railways have at all approached their full development in this country; while in the steam plough, in schemes of steam-drainage or water-supply, the employment of steam-produced hydraulic pressure, in the use of small gas-engines in workshops, and in a multitude of other ways, we have some indication of the increased future demand for coal.

VI. Economy, it may be pointed out, does not tend to reduce the industrial consumption of coal, but acts in the opposite direction: by increasing the profitability of coal-labour, it extends its use. Almost every improvement in the engine for the last century and a half has been directed to economising the consumption of coal; and yet the use of the engine and the quantities of coal consumed advanced *pari passu* with its economical performance.

It is altogether irrational to argue that progressive economy, which has coexisted with and been the partial cause of advancing consumption in the past, will have the opposite effect in the future.

VII. As regards the law of increase of coal consumption, both experience and theory lead us to believe that the increase takes place in a geometrical series, by multiplication rather than by mere addition. The following numbers will illustrate the difference in question:—

Arithmetical Series, increasing by addition. 1 2 3 4 5 6 7 8
Geometrical Series, increasing by multiplication 1 2 4 8 16 32 64 128

The following table will show that when we can get accurate statistics of the consumption of coal we find the increments indefinitely increasing, in the manner rather of a geometrical than of an arithmetical series.

Year.	Total quantity of coal imported into London Tons.	Increase in fifty years. Tons.
1650	216,000	—
1700	428,100	212,100
1750	688,700	260,600
1800	1,099,000	410,300
1850	3,638,883	2,539,883
1863	5,119,887	5,696,170*

The above and other statistics quoted in the 'Coal Question,'† Chapters IX. X. and XI. show that our industry grows by multiplication, and by multiplication at a rising rather than at a falling rate. The temporary depressions of trade which occur at intervals may sometimes seem to check the rapidity of this increase; but we have only to wait a year or two to see our industry advancing again with growing strides.

No statements of the total amount of coal produced in this

* Increase as for fifty years, if continued at same rate as during the thirteen years experienced.

† 'The Coal Question: an Inquiry concerning the Progress of the Nation, and the Probable Exhaustion of our Coal Mines.' By W.S. Jevons, M.A. 2nd ed. revised. London, 1866. (Macmillan.)

kingdom are the least to be relied on, except those collected by Mr. Robert Hunt, the Keeper of Mining Records, and the following is a statement of the general progress of the coal trade of the United Kingdom as ascertained by him:—*

Year.	Coal raised. Tons.	Coal exported. Tons.
1854.....	64,661,000.....	4,309,000
1855.....	61,453,000.....	4,976,000
1856.....	66,645,000.....	5,879,000
1857.....	65,394,000.....	6,737,000
1858.....	65,008,000.....	6,529,000
1859.....	71,979,000.....	7,081,000
1860.....	80,042,000.....	7,412,000
1861.....	85,635,000.....	7,222,000
1862.....	83,968,000.....	7,694,000
1863.....	88,202,000.....	7,529,000
1864.....	92,787,000.....	8,063,000
1865.....	98,150,000.....	8,585,000
1866.....	101,630,000.....	9,367,000

It is impossible to view, without some degree of alarm, so rapid an increase of the coal trade as the preceding figures indicate. Without doubt our production will advance to 200 millions before very many years are past; and the alarming calculation may be made that if we went on increasing our production of coal for 110 years as rapidly as we have done during the last 12 years, our coal seams would be worked out to a depth of 4000 feet. But such a supposition is put forward, not as a serious possibility, but as a *reductio ad absurdum*. The conclusion to be drawn from it is simply that the nation cannot possibly progress in material wealth for 110 years more as rapidly as it has done in the present century. The limited extent of our coal-fields would not allow us to go on increasing the draught of coal as lavishly as we have done. But it is the very necessity of changing from a highly progressive to a less progressive or stationary condition, that is most grievous. Population and production, when once set in motion, move with a certain impetus, and it is the check to such motion which is distressing and threatening.

VIII. The subject wears a more serious aspect still when we consider the coal resources and production of other countries as well as our own.

According to the latest returns which are at hand, it would seem that the total known produce of coal in the world is thus distributed over the chief nations:—

	Tons.
Great Britain.....	101,630,000
United States.....	25,800,000
Prussia and the Zollverein....	20,610,000
France.....	10,710,000
Belgium.....	9,935,000
Austria.....	4,500,000
British North America.....	1,500,000
Russia.....	1,500,000
Spain.....	300,000
New South Wales.....	250,000
Ireland.....	123,500
Total.....	176,858,500

It would appear then that of the total known produce of coal in the world we raise considerably more than half (57 per cent), although we form probably not more than one in forty of the population of the world. If to our own coal produce we add that of the United States and our colonies, we may conclude that the Teutonic race enjoys 73 per cent, or almost 3 parts out of 4, of the coal raised. It is hardly possible to over-estimate the forces acting in our favor which are represented by this partial monopoly of the most powerful material agent of civilization.

* I am kindly informed by Mr. Hunt that when the returns of the consumption of coal in 1867 are completed, the total will probably amount to 104,000,000 tons, showing continued increase in spite of the depression of trade.

The total quantity of coal existing can hardly be said to be known in the case of any one country; but some notion of the comparative coal resources of different countries may be gained from the following statement of the area of the coal-measures in the chief coal-producing countries, as estimated by Professor Rogers:—

	Area of Coal Lands in square miles.
United States.....	196,650
British North American Possessions	7,530
Great Britain.....	5,400
France.....	984
Prussia.....	960
Belgium.....	510
Bohemia.....	400
Westphalia.....	380
Spain.....	200
Russia.....	100
Saxony.....	30

Though Great Britain is far more abundantly provided with coal than any continental nation, our resources sink into insignificance beside those of North America, and no very long period will elapse before this comparative poverty in coal will make itself felt.

IX. It is continually suggested, indeed, that before coal is at all likely to be exhausted, some substitute will be found for it, and appeal is made to some old proverb, like "Necessity is the mother of invention." But it requires very little philosophy to see that the proverb is very partially true. We live in a chronic state of necessity and difficulty, and the great discoveries which we enjoy are but so many exceptional instances in which we have been unexpectedly relieved from labour and evil. We have no real ground for supposing that when one exceptional advantage is withdrawn from us, another will immediately be extended to us.

The favourite notion that electricity will be the future source of power is entirely fallacious; for the coal-driven engine moving the magneto-electric machine is now the cheapest source of electricity, and by gradual improvements, such as that in Mr. Wilde's machine, coal will become a still cheaper source of electricity. Even the elements of the electric battery have always been practically furnished by the reducing power of coal. If coal then become, as there is every reason to suppose it will, a cheaper and cheaper source of electricity, it is obviously absurd to suppose that electricity should supersede the power of coal.

It is conceivable, indeed, that in the course of ages some wholly new source of power might be discovered; but there is no reason to suppose that this island, which forms but the one four-hundredth part of the total land-area of the globe, would be as richly endowed with the new source of power as it is with coal. If the sun's beams are in the future to be the direct source of power, it is the plains of Africa or of Australia that will be the seats of industry and not this cloud-obscured Isle.

X. The conclusions we must come to on this subject are then as follows:—

1. The power of coal is extending itself and making itself more widely and deeply felt every day. It is more and more taking the place of wind, horse, or manual power, and is becoming the universal assistant.

2. We are naturally led every day to extend our consumption of so invaluable a substance, and experience shows that the more we use the more extensive are our augmentations.

3. Our consumption is already commensurable with our total supply; that is to say, we can form some notion how long our supply will endure with a stationary consumption.

4. As this consumption increases by multiplication, our national life becomes shortened, and it is apparent that the increase cannot go on very long at the present rate.

5. The moment we are forced to draw in, other nations, possessing far more extensive fields of coal compared with their annual consumption, will be enabled to approach and ultimately to pass us.

6. The exhaustion of our mines, as it will probably manifest itself within the next hundred years, will consist not in any stoppage of supplies, but an increase of cost, and the impossibility of increasing the consumption each year as at present.

XI. At some future time, then, when coal will be even a more useful agent than at present, we shall stand in a position of comparative inferiority. For such a time we can best prepare ourselves, not by short-sighted restrictions on the consumption or evaporation of coal, but by freeing the nation from its burdens of debt and ignorance and pauperism. We have many great tasks to perform, which can only be undertaken with a fair hope of success when the nation is in a state of high prosperity and progress. It will be too late to think of such great undertakings when our progress is checked, and the pressure of population and the want of employment are grievously felt. It is in a period of free expansion like the present that we can alone take any effectual measures for raising appreciably the standard of education, comfort, and morality of the people; and if we do not use the abundant wealth which our coal resources now afford us to fulfil such duties, we undoubtedly misuse it.

CHEMICAL SOCIETY.

Thursday, May 7.

DR. WARREN DE LA RUE, F.R.S., &c., *President, in the Chair.*

THIS meeting, as is usual on the special occasions set apart for lectures, was exceedingly well attended, and several visitors honoured the Society with their presence. Mr. E. Dowson was formally admitted as a Fellow, and Mr. Thomas Bournes, Teacher of Chemistry, 47, Rigby Street, St. Helen's, Lancashire, was duly elected. The names of candidates read for the first time were Mr. William Bowyer Miller, Assayer, Royal Mint, Sydney; and Mr. William Hustler, Mining Engineer, Rosemeryn, Falmouth.

Mr. C. W. SIEMENS, F.R.S., delivered a lecture "*On the Regenerative Gas Furnace as applied to the Production of Cast Steel.*" The lecturer announced himself to have been a pupil of Wöhler, and said he was prepared to estimate highly the value of chemical science in directing the studies of the engineer and electrician. The regenerative gas furnace, which has during the last few years been applied to the manufacture of iron and glass, and is destined to play an important part in other chemical operations, is the joint invention of Mr. Frederick Siemens and the lecturer. It was described in 1862 by Professor Faraday, and formed the subject of his last public lecture in the Royal Institution. Before proceeding to enter upon the discussion of the furnace itself, and its peculiar details of construction, Mr. Siemens briefly sketched the properties and modes of preparation of cast steel. This product was defined as being "a compound of iron and carbon, possessing the remarkable quality of becoming exceedingly hard when heated and suddenly cooled." The proportion of carbon determines its temper, and the following table, which was shown in the form of a diagram, indicates the average composition of steel of different qualities:—

Description.	Carbon per cent.	Authority.
Wootz.....	1.34.....	T. H. Henry.
Steel for flat files.....	1.2.....	Willis.
" for turning tools.....	1.0.....	"
" (Huntsman's) for cutters.....	1.0.....	"
" for cutters.....	0.9.....	"
" for chisels.....	0.75.....	"
Die steel (welding).....	0.74.....	"
Double shear steel.....	0.7.....	"
Welding steel.....	0.68.....	"
Quarry drills.....	0.64.....	"
Masons' tools and ramrods.....	0.6.....	"
Common steel for stamping.....	0.42.....	"
Spades and hammers.....	0.3 to 0.32.....	"

Description.	Carbon per cent.	Authority.
Bessemer steel for rails.....	0.25 to 0.30.....	Various.
Homogeneous metal (armour plates).....	0.23.....	Percy.
Very mild steel from open furnace.....	0.18.....	Willis.
Sample, before adding spiegeleisen.....	0.05.....	"
Bessemer iron (pure).....	trace.....	Abel.

Steel containing 1.4 per cent of carbon partakes of the character of white cast iron, and below 0.3 per cent the metal is incapable of being hardened. M. Frémy's opinion, that nitrogen (or cyanogen) is a necessary component of steel, was alluded to, and the probability of other elements being essential to its constitution was guardedly asserted. The presence of sulphur and phosphorus are undoubtedly prejudicial when they occur in considerable quantities, but the lecturer considers that traces of these elements may sometimes prove advantageous by increasing the fluidity and toughness of cast steel. The use of manganese fluxes, according to Heath's patent (1839), rendered it possible to prepare good steel from ordinary qualities of English puddled iron; and Mushet's discovery of the important advantages to be gained by the employment of ferro-manganese, or spiegeleisen, had paved the way to Mr. Bessemer's later triumphs. In the opinion of the lecturer, manganese has a special action in improving the quality of steel, apart from its function in removing sulphur and other impurities. Silicon, when present to the extent of 0.5 per cent, rendered it impossible to forge the ingots, but small quantities seemed, on the other hand, to be advantageous by preventing the evolution of gas in the interval between casting and solidification. The evidence respecting the effects of titanium, tin, and arsenic, was not conclusive; but Dr. Werner Siemens showed, in 1853, that tungsten had a remarkable action upon steel, in increasing its power of retaining magnetism when hardened. This property of tungsten was illustrated in the lecture-room by a small permanent magnet of horse-shoe form, which supported twenty times its own weight from the armature; the famous Haarlem magnet being incapable of lifting a weight more than thirteen times heavier than itself. The steel of which Mr. Siemens's magnet was made, contained about 2 per cent of tungsten, and 0.4 of carbon.

Reference was then made to the several processes of preparing steel, which were considered under the following heads, viz.:—The direct process in the Catalan forge; the method of cementation; the decarburisation process, or that which furnishes "puddled steel;" the Bessemer process; and, lastly, other methods of producing cast steel by fusion of malleable iron, or iron-producing substances, with cast iron, spiegeleisen, or other compounds containing much carbon, such as those practised by Uchatius, Price and Nicholson, G. Brown, Attwood, and others.

Experiments on the direct production of steel by a fan blast on an open hearth, according to M. Sudre's method, were made under the supervision of M. St. Claire-Deville and other two members of the French Institute; but the rapid destruction of the furnace, combined with the great cost for fuel, rendered the process a doubtful success. The applicability of the regenerative gas furnace to the fusion of steel and other metallurgical products, was partly established by the trials of Mr. Charles Attwood, in 1862, and of M. Lechatelier a year later, at Montluçon, in France; the gentleman last named melted together hot puddled blooms and cast iron upon a bed of the aluminous mineral known as bauxite, and subsequently upon a bottom formed of common white sand. Later, in 1864, MM. Emile and Pierre Martin melted steel, both in pots and on the open hearth, by the aid of the gaseous fuel of the regenerative furnace. Their products, consisting of cast steel of various qualities, were shown at the French International Exhibition, and rewarded by a gold medal. With the view of making for himself a series of practical trials on the production of steel, Mr. Siemens constructed two experimental furnaces, in Birmingham, and

succeeded in preparing steel of good quality, not only in closed pots, but on a continuous system direct from the ore. The details of these furnaces were explained with the help of large diagrams and dissecting models, whereby the leading points of their construction were clearly demonstrated. The principle of Mr. Siemens's plan of heating is already well known; the ordinary form of regenerative gas furnace having, indeed, been recently described by Mr. Henry Chance, who advocated its use in glass making. The fuel is heaped upon an inclined fire-grate, where it undergoes a kind of slow combustion, which results in the formation of carbonic oxide; this inflammable gas is then conducted from the "producer," to the hearth or working platform of the furnace, where it meets a current of air already raised to a high temperature, which enables it to burn with great intensity, and the excess of thermal power, instead of being allowed to pass directly into the chimney, and become thus wasted, is forced to traverse an intricate structure of brickwork, which absorbs so much of the heat, that the escaping gaseous products of combustion rarely indicate a temperature above 300° Fahr. At a suitable stage of the operation the gas valves are reversed, and both carbonic oxide gas and air forced to traverse these heated brick chambers in a contrary direction, so that they may in turn become the recipients of that heat which, in ordinary constructions of furnaces, would have been lost. The ashes and clinkers are in this way entirely separated from the region of manipulation, and are removed from the grate at intervals of one or two days. The composition of the inflammable gas varies with the nature of the fuel and the draught of the furnace; by way of illustration, Mr. Siemens quoted the following, as representing an average result for the gas from the producers at the St. Gobain plate glass works, where caking coal is employed in admixture with one-fourth of a non-caking quality:—

Carbonic oxide.....	24.2
Hydrogen.....	8.2
Carburetted hydrogen.....	2.2
Carbonic acid.....	4.2
Nitrogen.....	61.2
	100.0

Besides the above, there are always present aqueous vapour, tarry matters, and small proportions of sooty and earthy particles. The author estimates the temperature of the gas as it rises from the fuel at 1000 to 1300° Fahr., but it becomes considerably hotter in its passage to the area of combustion beneath the crown of the furnace. An ingenious electric resistance pyrometer, with platinum helix, which has done good service in measuring these elevated temperatures, was exhibited; and an experiment was performed in the lecture-room, for the purpose of demonstrating the principle of the "regenerators," lead being melted in the reversed current of hot air blown through a heated stack of flints previously ignited over a Bunsen burner. The special furnace, which serves for the direct production of steel, has a tunnel head, or cylindrical hopper, fed with iron ore and small coke passing through, and raised above, the crown of the regenerative gas furnace; the lower part of this upright cylinder rests in a bath of molten pig-iron, which dissolves the reduced (spongy) iron as quickly as it is separated from the ore. A blast-pipe descends through the stack of ore, and the process is interrupted when the steel is ready for casting, after which the charge of pig must be renewed.

In the case of using bar iron (worn out rails) in the preparation of steel, they were introduced into an inclined hopper with their lower ends resting in a bath containing 10 per cent (by weight, of molten pig; and the atmosphere of the furnace might be changed at will into an oxidising, reducing, or perfectly neutral condition, merely by altering the proportions of air and gas. It is important to keep the carbon at a minimum, for then the silicon is lowest.

The lecture was amply illustrated by a series of diagrams

showing the construction of the several kinds of regenerative furnaces in plan and section, and a large model of a gas producer was upon the table. The following specimens were also exhibited:—

Cast steel produced by melting Bessemer scrap in Siemens's furnace.

Cast steel produced by melting iron rail ends from Hayance, France, containing nearly 1 per cent of phosphorus.—Siemens's furnace.

Magnet steel containing tungsten.—Pot furnace.

Steel made in open furnace from Staffordshire iron.—Carbon, 0.37 per cent.

Steel from puddled iron from Creusot.—Open furnace. Carbon, 0.38 per cent.

Ingot of steel made in open furnace from red and cold short metal.—Carbon, 0.4 per cent.

The same metal tilted.

Steel made from Bessemer scrap in open furnace, containing 0.46 per cent of carbon.

The PRESIDENT, having proposed a vote of thanks to the lecturer, took occasion to remark that the regenerating furnaces offered special facilities for making experiments upon steel, with the view of ascertaining the effects of different adventitious substances. The statement of the wonderful magnetic properties of tungsten steel surpassed all that the Dutch had accomplished, and it would now be interesting to study the influence of boron.

A discussion followed, in which Mr. Cowper, Professor Abel, Dr. Miller, Dr. B. H. Paul, Dr. Williamson, and Dr. Odling took part. The meeting was then adjourned until the 21st instant.

Thursday, May 21.

Dr. WARREN DE LA RUE, F.R.S., &c., President, in the Chair.

THE minutes of the previous meeting were confirmed, and the names of candidates for admission into the Society were read:—For the first time, Mr. H. B. Riddell, late of the Indian Civil Service, 9, Stratton Street, Piccadilly; and Mr. Samuel Alexander Sadler (at Messrs. Chance's Chemical Works), Oldbury, Birmingham. For the second time, were read the following names:—Henry Chance, M.A., Glass Manufacturer, Birmingham; William B. Miller, assayer, Royal Mint, Sydney; and William Hustler, Mining Engineer, Rosemerry, Falmouth.

Dr. W. J. RUSSELL described "Some Experiments on the Application of the Measurement of Gases to Quantitative Analysis." The author has made experiments for the purpose of testing the accuracy of a system of measurement, instead of weighing, in a variety of analytical operations wherein gases are evolved. The illustrations given in the paper have reference to the treatment of sodium and calcium carbonates with sulphuric or hydrochloric acid; manganese peroxide, decomposed by a mixture of oxalic and sulphuric acids; and, finally, zinc, magnesium, and other metals evolving hydrogen when undergoing solution in diluted acids. The apparatus employed consists of a eudiometer or measuring tube having attached to the top, at right angles, a flexible india-rubber tube, cemented on tightly with marine glue. This tube serves to connect it with a small flask, or bulb, in which the analytical operation is conducted, the acid being kept separate from the carbonate or metal in the usual manner (by a glass tube within), until all is ready for starting the decomposition; the gas and air measured before and after the experiment gives by difference the amount of hydrogen, carbonic acid, &c., evolved. India-rubber has been found to absorb notable quantities of the last-named gas by long contact, but the error from this and other sources proves to be very trifling, the following results having been obtained by Dr. Russell:—

CO₂ from carbonate of soda—

Theoretical quantity..... 41.509 per cent.

Mean of eight experiments..... 41.533 "

Mean of other five experiments... 41.431 "

CO₂ from calc spar—

Theoretical quantity..... 44.000 per cent.

Mean of 13 experiments (HCl).... 43.719 "

" 9 " (").... 43.812 "

" 5 " (").... 43.736 "

" 5 " (HNO₃).. 43.924 "

Manganese ore—

I. MnO₂..... 58.156 per cent.

II. "..... 58.101 "

Hydrogen from zinc foil—

Theoretical amount..... 3.0769 per cent.

Pure—mean of 3 experiments..... 3.0757 "

Ordinary ditto..... 3.0504 "

Hydrogen from magnesium foil and ribbon—

Theoretical amount..... 8.333 per cent.

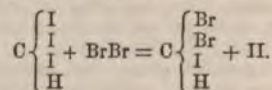
Pure—one experiment..... 8.281 "

Ordinary—mean of 4 experiments. 8.265 "

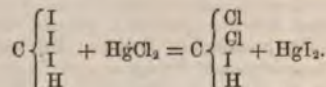
The PRESIDENT, in returning a vote of thanks to Dr. Russell, took occasion to remark that the experience of microscopists confirmed the statement relative to the permanent character of a junction made between glass and marine glue.

Dr. A. W. WILLIAMSON considered that the foregoing would be an exceedingly valuable addition to our methods of analysis, and no doubt capable of extension. As a rule, the process of measurement can be conducted with greater accuracy than by weighing; for whilst we could not weigh closer than one-tenth of a milligramme in our best balances, it was possible to measure volumes of gas within one-hundredth part of a cubic centimetre.

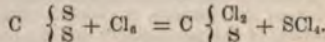
Mr. W. H. PERKIN then read a paper entitled, "Observations upon the Combining Powers of Carbon." The author addresses himself to the inquiry whether all four affinities, or combining units, of carbon are of equal value, and examines with this object the constitution of a great number of carbon compounds both simple and complex. Mr. Perkin concludes that the combining units of carbon are arranged in two pairs of very widely different chemical values, and proposes to indicate this difference in formulae by drawing two thick lines for the stronger, and two thin lines for the weaker affinities. He deduces this conclusion from the fact that iodoform loses but two out of its three atoms of iodine when acted upon with bromine, or distilled with chloride of mercury, thus:—



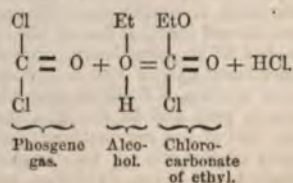
and



In a similar way disulphide of carbon, when attacked by chlorine, gives an intermediate product, thus:—

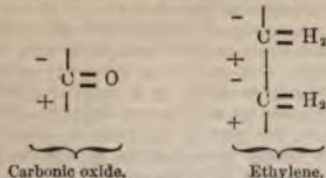


Mr. Perkin's views may be well illustrated by quoting another example, one of many described in his paper, thus:—

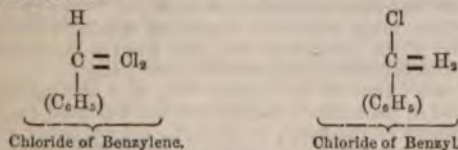


In the instances of carbonic oxide and ethylene, where the carbon affinities are not satisfied, the author suggests

that in these bodies the stronger units are in combination with O and H₂ respectively, and the weaker pairs are neutralised by virtue of a kind of polarity, thus:—



The following experiments were shown by Mr. Perkin. Some dry oxalate of silver in a test tube was brought into contact with chloride of benzylene; when the action had commenced, at first slowly, a delivery tube was adapted and the evolved gases collected over water were shown by appropriate tests (potash absorption and inflammation of the residue) to consist of a mixture in equal volumes of carbonic acid and carbonic oxide. A comparative experiment was likewise made for the purpose of showing the difference in the action of sodium alcohol upon chloride of benzylene, and chloride of benzyl in alcoholic solution, both being heated by immersion in boiling water; the latter soon gave a copious deposit of chloride of sodium, whilst the contents of the other tube remained clear. The difference in the behaviour of the two bodies was explained by assuming that the chlorine was tied to the carbon by a weak bond in the chloride of benzyl, and by a strong double union, or affinity, in the case of the chloride of benzylene. Their constitution was thus sketched:—



The author concludes his paper by stating his views in the form of three propositions:—

1st. That the units of combination possessed by an atom of carbon consist of two pairs of greatly different values.

2nd. That the units of each pair are chemically of slightly different values; and that they appear to possess some kind of polarity, thus rendering it intelligible that two units of combination in one atom may neutralise each other.

3rd. That in poly-carbon compounds the weak units of combination of one atom of carbon may unite with the strong units of a second atom.

The PRESIDENT moved a vote of thanks to Mr. Perkin, and invited an expression of opinion from Sir Robert Kane, Dr. Williamson, and others whom he saw in the room.

Dr. A. W. WILLIAMSON demurred in accepting the view put forward by Mr. Perkin, and considered that this was an example of the grave errors sometimes committed by chemists, when attempting to follow in the path of Kekulé without heeding the pitfalls against which that author had specially warned them at the outset. It was a mistake to assume that when one atom of hydrogen in marsh gas was replaced by chlorine, and the new body, CH₂Cl, came in turn to be attacked by chlorine, that because a greater difficulty was experienced in the second replacement a different degree of affinity must necessarily be exerted between the carbon and one or the rest of the original hydrogen atoms. The fact was that at the first stage the properties of the body were entirely changed, and we have afterwards to deal with a new system, and the effects produced in the two cases have, therefore, no assignable relation one to the other. Taking a simpler case, that of water, H O H. When attacked by sodium a hydrate was produced, H O Na, which exhibited new properties; and

when we proceeded further to replace the remaining atom of hydrogen in this hydrate it could not be said that we were at that moment dealing with water, nor could it be inferred that because one H left before the other it was originally held in weaker union with the oxygen. Professor Williamson instanced other examples of hydrogen replacement, SO₂ for H₂ in the case of hydrated sulphuric acid being formed from two atoms of water; and, then, whether one or both of the remaining hydrogen atoms were replaced by potassium, it was impossible to observe any difference, or imagine any distinction, between the two atoms of hydroxyl, or of hydrogen, in these compounds. The speaker objected to the use of the words, "atomicity" and "bond," and said that although Kekulé protested at first against a wrong use being made of these terms, his mind seemed afterwards to have become warped by constant misapplication of them on the part of others, for he had come at last to use them himself in the sense against which he formerly objected.

Dr. ODLING agreed heartily with all that Dr. Williamson had said, but still felt thankful to Mr. Perkin for having brought the subject forward for discussion. The hypothesis which asserts that an atom of carbon is provided with bonds of which each has a specific function is not new, having been already described in "Watts's Dictionary of Chemistry" and discussed by Erlenmeyer and others. It seemed to be necessary to wait for facts: Dr. Williamson had alluded to the two chlorides of methyl formerly supposed to exist, and some chemists believed there were two bromides of ethyl. Referring to Mr. Perkin's illustrations, the four bonds of carbon instead of being extended at right angles would, if written in a straight line, be shown thus = C =, but in attempting to explain the constitution of carbonic oxide there was nothing to show whether the oxygen atom stood on the right hand or left; in either case there would be a hypothetical copulation of unsatisfied affinities.

Dr. HUGO MULLER disputed the inferences drawn from the asserted impossibility of converting the chloride of benzylene into a tri-chlorine compound, the fact being that this could be accomplished by the continued action of chlorine.

Mr. PERKIN, in reply, reminded his hearers that he had purposely abstained from the use of the word "bond," and employed throughout his paper the term "combining unit." Chloride of benzylene was produced by the action of pentachloride of phosphorus upon the oil of bitter almonds, and he was not aware that the chlorination of this product could be pushed further. He still wanted an explanation of certain facts; for instance, when the vapour of bichloride of carbon is passed through a red-hot tube it gives up part of its chlorine; but why does this happen if the combining units are of equal value? and again, why does carbon rob carbonic acid of half its oxygen?

Dr. ODLING said it would be easier to take a hundred-weight out of the possession of a man who was loaded with two, than if he were holding but one.

Mr. JOHN PARNELL then read a short paper, and exhibited a few experiments "On the Reducing Action of Peroxide of Hydrogen and Carbohydric Acid." The leading feature of this communication was a new colour-test for the detection of peroxide of hydrogen, which was shown to be much more delicate in its indications than the ordinary ethereal solution of chromic acid. The "ten-volumes preparation" of Messrs. Garden and Robbins was diluted with thirty times its bulk of distilled water, and 1-10th c.c. only taken for the experiment. This was added to a mixture previously made of aqueous carbohydric acid and ferrous sulphate, when a permanent green colouration was produced in the cold. When, however, the ferrous sulphate and peroxide of hydrogen were previously mixed, only the usual violet colour, as with ferrous salts, appeared on addition of the carbohydric acid. The results obtained by varying the circumstances were shown at the meeting, and a somewhat remarkable reaction with the chloride of aluminium was described.

Dr. HUGO MULLER attributed the results observed to the

production of oxyphenic acid, which is a powerful reducing agent; and the pink colour noticed in the case of chloride of aluminium may possibly have been due to the formation of rosolic acid.

A vote of thanks having been given to the author, the President adjourned the meeting until Thursday, 4th June, when Mr. Chapman will read papers "*On the Artificial formation of Pyridine*," "*On a New Reaction for the formation of Isomeric Cyanides*," and another short note. Dr. B. H. Paul will describe "*A mode of Testing Mineral Oils used in Lamps*."

ROYAL DUBLIN SOCIETY.

May 4th, 1868.

DR. J. M. BARRY read a paper "*On the Physical Geography of the Southern Ocean*." The cause of the calms, trade winds, &c., was discussed. Dr. Barry concluded his paper with some remarks on the magnetic phenomena of the Southern Hemisphere. The point of least intensity on the globe was stated to be in the middle of the South Atlantic.

Mr. WALTER G. SMITH, M.B., then read an exhaustive paper upon the subject of "*A Black Wax that was Imported from Madras in the year 1862*." (The specimen is at present in the Museum of Materia Medica, Trinity College, Dublin.) The cake consists of two distinct layers—the upper one of a jet black colour, and its recent fractured surface being somewhat conchoidal; the lower layer is browner, with a granular fracture. The cut surface exhibits a waxy lustre. The specific gravity of the upper layer is 0.985, a somewhat higher density than that of bees-wax, which averages 0.96, and the specific gravity of the thinner brown layer is 1.462. The fusing point of the black portion is about 148° F., or nearly the same as that of ordinary wax. Very little could be said as regards its natural history, but the author concluded, from reasons that he gave, that it owed its origin to a particular species of bee. No mention is made of any similar substance in any of the modern works, except an early volume of the *Pharmaceutical Journal* (vol. xii., 1853, p. 401). There is an allusion in that book to a curious wax which had been imported from Brazil, the product of a black bee which lived under ground. It was soft and exceedingly tenacious, and of a dark mahogany colour.

The following is the *modus operandi* by which the author examined this wax:—

3000 grains were exhausted with boiling rectified spirit, filtered and washed. The dark brown residue left undissolved by the alcohol was treated frequently with ether, and filtered. On the spontaneous evaporation of the ether, a brown colouring matter remained. This colouring matter was easily soluble in bisulphide of carbon, in benzol, and in chloroform, and when heated with hydrate of potash, turned black and evolved ammonia. It fused very readily, and did not appear to be acted upon by a strong alcoholic solution of potash. The black substance insoluble in the ether was digested with chloroform, which immediately formed with it an opaque, treacly fluid.

This substance also evolved ammonia when heated with caustic alkali.

The first alcoholic filtrate was concentrated to a small bulk, and cooled, to allow the cerotic acid to deposit. The precipitated acid was then filtered off. The cold alcoholic solution was evaporated to dryness, and the residual cerolein weighed. The results of the analysis are as follows:—

	Black wax.	Bees-wax.
Myricin	—	73
Cerolein	15.054	5
Cerotic acid	63.602	22
Colouring matter insoluble in ether	17.088	—
Ditto soluble in ether	4.253	—
	99.997	

The identity of the cerolein with that obtained from bees-wax is shown by its being acid to litmus paper, fusible at a very low temperature, soluble in ether, and quickly purified by a hot alcoholic solution of potash.

The percentage amounts of cerolein and of cerotic acid are each about three times as great as in bees-wax, and the proportion of cerotic acid varies in different samples of wax. (It was entirely wanting in a specimen of Ceylon wax, and in a wax made by wild bees in Surrey.—Brodie.)

The myricin, i. e., the portion insoluble in alcohol, and which constitutes nearly three-fourths of the weight of common wax, seemed to be replaced by the two brown colouring matters.

The author does not state if the wax is capable of being practically bleached.

BAVARIAN ACADEMY OF SCIENCES.

At a meeting of the Bavarian Academy of Sciences, held on the 10th of May, the President, Baron von Liebig, delivered a lecture "*On Fermentation and the Source of Muscular Power*." It was shown that Pasteur's celebrated discovery of the increase and propagation of the yeast fungi in a mixture of tartrate of ammonia, sugar, and yeast ashes, rested on a palpable error.

Liebig explained that, according to his analysis, the chief constituent of the yeast was a substance similar to the casein of milk, containing nearly 1 per cent of sulphur, and recognisable when in putrefaction, even by the unprofessional, through the odour of rotten eggs.

As the materials which Pasteur employed for the growth of the yeast fungi, contained no sulphur, it follows that his assertion of the increase of the yeast fungi in the mixture of the said substances is simply an impossibility.

The proof adduced by Pasteur, viz., that the ammonia contained in his mixture disappeared and was used for the nourishment of the fungi, is characterised by Liebig as a superficial observation.

Pasteur overlooked the fact that his mixture contained soluble and insoluble phosphates, due to the yeast ash, and that on expelling the ammonia with caustic magnesia the well-known phosphate of ammonia and magnesia must be formed, and that, hence, the very means he employed to ascertain the amount of ammonia rendered the solution of this question impossible. The ammonia, then, which disappeared, had not been employed in the growth of the fungi, but simply had entered into a chemical combination whose formation Pasteur had overlooked.

It has been observed that fresh pure beer-yeast left to itself, in the presence of water, disengages carbonic acid and produces alcohol. Liebig found that the power of yeast to excite fermentation is retained as long as this process is going on; at its close putrefaction sets in.

Liebig regards this process as a vital act in the interior of the cell, and as the immediate cause of the action of yeast in the fermentation. When a solution of sugar comes into contact with the yeast cell, the inner decomposition of the latter is retarded, and the molecules of sugar in contact with the cell are decomposed.

One hundred parts by weight of yeast left to themselves furnished 9.18 per cent of alcohol. Pasteur has assumed that this alcohol is produced from the cellulose of the yeast, which had changed itself into sugar. If this assumption were true, the cellulose ought to disappear entirely: it remains, however, unaltered behind.

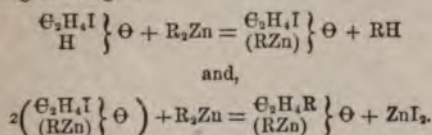
During the formation of alcohol no trace of ammonia is generated. As some of the most remarkable products of this vital process, Liebig mentioned leucine and tyrosine, and a nitrogenous substance containing a certain amount of sulphur.

With regard to the investigations of Fick, Wislicenus, and Frankland, which have been regarded by many as a proof against Liebig's theory of the mode in which muscu-

lar power is generated, Liebig remarked that they rest upon imperfect conceptions of the nature of the organic process involved. It was just as impossible by the combustion of dried muscle to calculate its efficiency in the living body (the assumption of these physicists) as it was by the combustion of a dried bee to estimate the work which it accomplishes in the flight of many hours, carrying the weight of its own body several miles. The muscle in the living body acts like the apparatus in a watch, which gradually expends the power stored up in it. A freshly-severed frog's leg represents an apparatus of this kind with an escapement, while the newly-removed heart of the same animal corresponds to one without escapement; the frog's heart beating for hours together, just as in the living body, while the frog's leg moves as soon as an irritant sets it for a moment free from the escapement; and if small weights are hung on them, it is possible to obtain work from a pair of severed frog's legs, that is, the weight will again and again be alternately raised to a certain height, without blood or the supply of any kind of nourishment.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

New Synthesis of Alcohols, and Chemical Structure of Ethylene.—Butlerow and Ossokin have acted upon ethylglycoliodhydria with zincic methide and ethide with a view of obtaining alcohols, from the nature of which conclusions might be drawn as to the chemical structure of ethylene present in the iodhydria. The reaction proceeds in the following two stages:—



By decomposing the compound last formed with water, the alcohols are obtained, and they were found to be secondary (iso-)propylic—when zincic methide was used—and secondary butylic alcohol—in the case of zincic ethide. It would follow from these experiments that the structure of ethylene is



as, however, all other reactions of ethylene lead to the formula



it is supposed that in the present instance its structure changes from the latter to

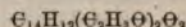


—(*Zeitschr. Chem.*, N.F. iii., 680.)

Silvering of Glass.—Liebig. After a long series of experiments, the author finally adopted the following process for silvering glass. The solutions employed are:—I. One part of fused argentic nitrate dissolved in 10 of water; II. (a) commercial nitric acid, free from chlorine, neutralised with ammoniac sesquicarbonate, and diluted to sp. gr. 1.115; or (b) 242 gr. ammoniac sulphate dissolved in 1200 c.c. water (sp. gr. 1.105 to 1.106); III. Solution of sodic hydrate sp. gr. 1.050 prepared from sodic carbonate, free from chlorine; IV. 50 grm. white sugar candy dissolved in little water, 3.1 gr. tartaric acid added, the mixture kept boiling for one hour, and diluted to 500 c.c.; V. 2.857 gr. dry cupric tartrate, covered over with water, and solution of sodic hydrate gradually added till solution has taken place, and solution made up to 500 c.c. These solutions are mixed in the following propor-

tions:—1st, 14 vol. of I., 10 vol. of II., and 75 vol. of III.=99 vol. of (A) silvering solution; 2nd, 1 vol. of IV., 1 vol. of V., and 8 vol. of water=10 vol. of (B) reducing solution. The silvering mixture is then made by diluting 50 vol. of the silvering solution (A) with from 250 to 300 vol. of water, and adding 10 vol. of the reducing solution (B). If ammoniac sulphate has been employed for solution (A), the liquid, after mixing the three ingredients, must be allowed to stand three days before being used; the clear liquor may then be drawn off.—(*Ann. Chem. Pharm. Suppl.*, v., 257.)

On some Compounds of the Toluol-group.—H. Limpricht and H. Schwanert. Toluylene C_6H_5 is converted into dibenzyl $\text{C}_6\text{H}_5\text{CH}_2$ by the action of iodhydric acid. It combines with bromine to $\text{C}_6\text{H}_5\text{CH}_2\text{Br}$, which on distillation or treatment with alcoholic potassic hydrate changes to bromtoluylene $\text{C}_6\text{H}_5\text{CH}_2\text{Br}$. This again combines with bromine forming a crystalline body $\text{C}_6\text{H}_5\text{CH}_2\text{Br}_2$. Continued action of alcoholic potassic hydrate removes the whole of the bromine with formation of tolan C_6H_5 , a well crystallising hydrocarbon isomeric with anthracene. Tolan forms the bromide $\text{C}_6\text{H}_5\text{Br}$, which is reconverted to C_6H_5 by alcoholic potassic hydrate. Bromtoluylene shows the reaction of the bromide of a diatomic alcohol; with argentic acetate toluylene acetate



is produced, and this is converted by means of alcoholic potassic hydrate into toluylene alcohol $\text{C}_6\text{H}_5\text{CH}_2\text{O}$, which is identical with Zinin's hydrobenzoin.—(*Zeitschr. Chem.*, N.F. iii., 684.)

Solubility of Silicic Acid in Ammonia.—Richard Pribram has investigated this behaviour and found that SiO_2 is taken up by ammonia in the following proportions: natural anhydrous requires 6000, artificial anhydrous 260, hydrated dried 330, gelatinous 140 parts liquor ammonia of 10 per cent. Exposed to the air NH_3 evaporates, and finally a clear solution of $\text{NH}_4\text{O}_4\text{SiO}_3$ remains. By boiling, about 19-20ths of the remaining ammonia is expelled, and the clear solution contains about 80 of SiO_2 to one NH_3 . Dried at ordinary temperature the residue has about the same composition, but water takes up mere traces of it. The results give a hint of the manner in which silica may be administered internally, and how plants most likely take up this compound.—(*Wittst. Viertelj.*, 1867, 30-41.)

NOTICES OF BOOKS.

Tea. By E. F. BAMBER. London: Longmans. 1868.

THE author, who has lived for some years in the tea-producing districts of Asia, has produced a very readable little book. He first goes into the historical part of the subject; then he discusses fully the cultivation of the plant, and the manipulation the leaf undergoes before it becomes an article of commerce, and explains what constitutes the difference between the three classes into which tea may be divided:—*Flowery Pekoe, Green Tea, and Black Tea.*

It is a great pity that a writer who is so fully conversant with his subject should not confine himself to that with which he is familiar, but should diminish the trustworthy character of his book by speaking authoritatively on matters concerning which he appears to be profoundly ignorant. The section in which Mr. Bamber explains the chemistry of tea is remarkable as showing the unhesitating manner in which a writer ignorant of the veriest elements of chemistry will criticise the results obtained by one of the leading chemists of the day. Speaking of Theine, Mr. Bamber writes:—

"Theine cannot be produced artificially. Water decomposes this compound easily, and Hydrochloric Acid evaporates from it in warm air, so weak a base is Theine." In referring to Mulder's analysis, it will be remarked that Muriatic Acid extracts form nearly one-fifth of the whole weight of Tea; and Muriatic Acid and Hydrochloric Acid are synonymous terms."

The following passage is, in our opinion, inimitable:—

"Mulder's analysis is considered the best that has been made of Tea. It appears not to be a very good one; for Muriatic Acid has a strong sour taste, and if Tea had, one-fifth of its total constituents, Muriatic Acid Extract, it should have a strong sour taste, which it has not; probably the Theine in the Tea which he analysed had turned into Muriatic Acid. As a proportional analysis, Mulder's can carry with it but little authority, for the totals of the parts of each of the Teas disagree. Still it has its use, for where Mulder states that there was no trace of a constituent, probably there was none."

The Inductorium, or Induction Coil. By HENRY M. NOAD, Ph.D., F.R.S. London: Churchill & Sons.

WE noticed the first edition of this useful little volume on its appearance in 1866. It gives us pleasure to have the opportunity of here recording the issue of the third edition, containing several additions and improvements. Amongst these we notice a description of Wheatstone's and Siemens' automatic or self-charging electro-magnet, and the ingenious method of utilising the current energy evolved by these machines in the modification constructed by Mr. Ladd. Dr. Noad's description of the somewhat complicated principle involved in these machines is so clear that we are induced to quote it for the benefit of our readers.

On page 32 he writes: "In this curious contrivance the terminals of a revolving armature are (with the intervention of a commutator, to change the direction of the alternate induced currents) placed in connection with the terminals of the electro-magnet coil. Now if the iron body of the electro-magnet were absolutely free from magnetism, no action would issue from the rotation of the armature; but practically that is never the case, for the mass of iron is never absolutely pure and soft; it consequently always retains a small portion of the magnetic polarity which was last induced in it, by the transmission of an electric current through its coil, consequently on the first semi-rotation of the armature, a minute induced current is evolved; but this, in consequence of the connection described, is returned into the electro-magnet coil, and slightly exciting the electro-magnet, a slightly stronger induced current is delivered by the armature, during its second semi-revolution; and so on successively, until the currents induced in the rotating armature acquire a very high degree of energy. If the primary coil of an inductorium be now interposed in the circuit as in Professor Wheatstone's apparatus, sparks of considerable length may be obtained between the terminals of the secondary coil; or a certain length of platinum wire will become incandescent. It may here be remarked that as the energy of the induced currents is augmented, the resistance of the armature to rotation, and consequently the amount of dynamic energy necessary to rotate it is similarly augmented. This fact presents a strong confirmation of the theory that an electric current is merely an undetermined form or mode of energy, and that, by the mediation of the machine here described, dynamic is converted into electric energy."

Mr. Ladd's machine is similar to the above: he employs a second armature, placed between the contrary ends of the plates which constitute the electro-magnet, in which an equal current is induced as in the armature already described; this latter current may be utilised in any required manner.

Mr. Ladd has allowed us to use some of the very beautiful wood-cuts which adorn this book, to illustrate his dynamo-magneto machine which gained the silver medal at the Paris Exhibition, 1867. In this machine (Fig. 1), the ends A of the electro-magnets, B, are firmly screwed to two pairs of

iron prolongations, C, forming two cylindrical cavities in which the two armatures, M, N, are rotated in the same direction by two bands passing over a common drum. The armature, N, returns its currents into the electro-magnet, while the currents from M are utilised, as in producing the electric light between the carbon terminals, D.

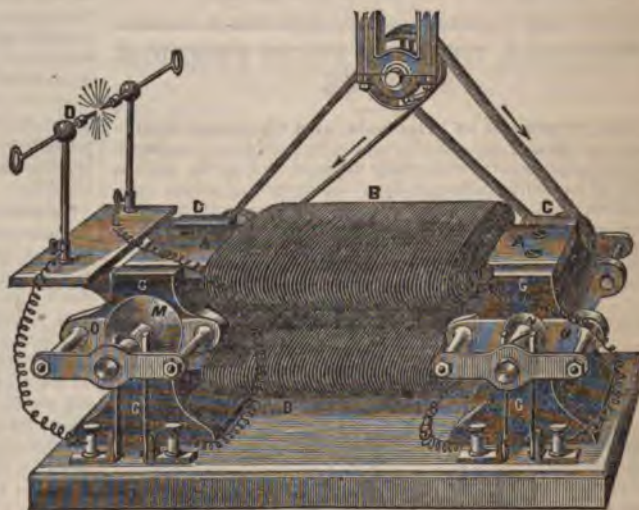
In another form of the apparatus constructed by Mr. Ladd, the two armatures of the former are combined in one, and the coils are wound at right angles to each other as shown at A and B in Fig. 2.

Of these coils the shorter, B, feeds the electro-magnet, and the longer, A, furnishes the utilised current.

The results to be derived from these dynamo-magneto machines are always in proportion to the power expended, and the only limit appears to be the rapidity with which the armatures can be rotated.

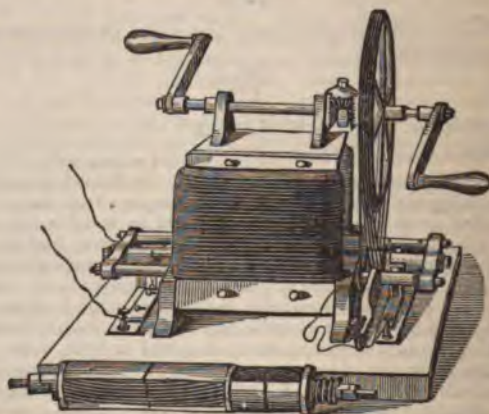
Mr. Beanes's ozone generator, of which so much has been heard and so much more is expected, is here described. The

FIG. 1.



object for which it was made was to produce ozone in very large quantities, so as to apply it to commercial purposes, such as decolourising sugar, oils, rags, &c. For this purpose

FIG. 2.



an apparatus was made as follows:—"Thirty plates of thin glass 18 in. by 9 in., each plate being coated with tinfoil on

one side and separated from those next it by slips of glass placed along two edges so as to leave a series of thin broad channels, for the passage of the air to be ozonised, each coating being alternately connected together in a similar way to a condenser of an inductorium; the whole is then placed in a well-made box thoroughly protected with shellac to prevent the ozone acting upon the wood; the box is left sufficiently long to allow of two openings, one at either end beyond the glass plates, for the passage of a current of dry air; the ends of the box have glass plates inserted for observation. The area between the plates in the above apparatus was about 14 square inches; the two terminals of the coatings are insulated through the box, and when connected with a good inductorium, a glowing discharge will be seen between the plates of glass, and as one discharge is sufficient to ozonise the air at that instant between the plates it is evident that a very rapid blast can be sent through, and an enormous quantity of ozone obtained; it is essential that the air should be cold to properly ozonise, but a moderate amount of heat afterwards does not affect it. The pipes conveying the ozone should be of lead, tin, or glass; there are but few other substances that are not affected by it."

Braithwaite's Retrospect of Medicine. Vol. lvi.

FOR more than a quarter of a century this most useful compilation has rendered good service to the medical profession. The present volume contains no fewer than six papers, amongst others from the authoritative pens of Lister, Syme, and Sir J. Y. Simpson, "On the application of Carbolic Acid to Practical Surgery." Whether according to Pasteur, carbolic acid acts by destroying the septic organisms, which probably in myriads infest the air of hospitals, or whether, according to his antagonist Pouchet, it operates in some undetermined manner, by preventing oxidisable matter passing into a putrid condition, certain it is that this agent is effecting a beneficent revolution in surgery. A large proportion of the disasters and deaths which arise from compound fractures, wounds, and amputations, is caused by the decomposition of blood and sloughs. The evidence contained in this retrospect shows that carbolic acid, properly employed, prevents this corrupting change, and warrants the assertion that the boon which chemistry has conferred on medicine will avert a measureless amount of suffering and death.

The London Student. No. 1, 1868. John Churchill and Sons. THE appearance of this, the first number of a new monthly journal devoted to educational purposes, deserves a cordial welcome from all who are interested in the intellectual progress of this country. Whatever opinions may be formed as to the want of such a periodical—and it may be thought by some to be almost too serious and ambitious an undertaking to enter into successful competition with its lighter contemporaries—there can be no question that this number, from the intrinsic merit of its contents, deserves a circulation far and wide, and the most serious attention from all who are in any way connected with educational pursuits.

The work commences with a plea for more universities, by Professor Seeley, who strongly urges the advisability of a union between the London Colleges, and the consequent formation of a London University worthy of the name. "If," as Professor Seeley eloquently urges, "the British Museum is a university; if every hospital is a medical university; if the Royal Academy is a university of Art; if besides these, there exist in London a number of so-called colleges, in which the fundamental condition of the university system is fulfilled—namely, that the teacher is not absorbed in teaching, but has leisure for study and research; lastly, if London is the head-quarters of all those learned societies—which are universities in the purest rudimentary form—may we not justly say that London contains the chaos of the vastest university in the world, and that little more than a word is wanting to call that university into being? These multitudinous institutions have but to unite—nay, they have but to will to unite, and the thing is done. If I may use a bold

figure, London, the head of the empire, conceals behind its capacious forehead an intricate network of nerves, in the convolutions of which go on thought, observation, speculation, but no one has thought of giving a name to the mass. Let us once learn to think of it as a whole, and we shall see that it is the brain of the country."

But before the London colleges can unite permanently they must make each other's acquaintance, and grow accustomed to each other's society, and on this point Professor Seeley writes:—

"It has long been discovered that as a cement and symbol of unity among men, that have similar interests and are engaged in similar pursuits, there is nothing more useful than a magazine. The *London Student* has been projected with the view of representing the University in London, both to its members and to the outer world. To the colleges themselves, both governing bodies and students, it will display the deficiencies of this great University; to the world it will display its merits. What these deficiencies and merits are, has now, I hope, been made clear. It wants unity and organisation; it possesses everything else which the age requires in a university—a vast assemblage of learned men, vast museums and libraries, variety of instruction, cheapness, absence of great endowments, a disposition to make progress and try experiments, and lastly religious comprehensiveness."

The most important paper, and certainly the one most likely to interest the readers of the *CHEMICAL NEWS*, is on "*Experimental Science the basis of General Education*," by Professor Williamson. We make no apology for placing before our readers the following extracts from this eloquently written article:—

"If a man were entitled to a rich and glorious inheritance, of which the possession would open up to him an extensive sphere of usefulness and happiness, and if he did not claim his rights, one would naturally suspect that he was not aware of their existence, or that he had not been correctly informed of their value."

"The English people is now in the position of such a man, for it is undisputed heir to the noblest estate in the world, and has never taken possession."

"The estate is managed by trustees who reside upon it and honestly devote their whole energies to its improvement, while supplying the heir with rich and abundant produce."

"From time to time the estate is visited by friends of the heir-at-law, but a strange fascination prevents their ever returning to him. Once their feet have touched the soil, they are drawn onwards and upwards till they find themselves among the trustees, with whom they set to work improving the estate. Meanwhile the heir is living in foreign parts, satisfied with the rich produce which reaches him. Messages are sent to him to come and take possession, and enjoy the estate himself, but he heeds them not, for travellers who pass by its outskirts tell him that they do not see much in it, and that the only good thing about it is the produce which he receives."

"This unclaimed inheritance will no doubt be named when it is sufficiently known. Meanwhile we may describe it as knowledge:—

"Knowledge of the most trustworthy and serviceable kind:

"Knowledge of the phenomena of nature:

"Knowledge of man's own powers and their limits, just sufficient for the purpose of obtaining more:

"Knowledge of the order of nature and of the rudiments of her laws."

"Experimental science, which is the embodiment of such knowledge, is usually associated in England with the name of Francis Bacon, who so emphatically proclaimed that its methods afford the only safe guide to the human reason in the search for truth."

"The trustees whose labours develop it in all directions, are those who question nature by rational experiment, and record her answers, arranging them in intelligible order like letters into words, and learning from these words the laws of nature. These experimentalists supply man with num-

berless useful and agreeable products. Their numbers are constantly increased by new members, who enter upon science with the desire of seeing what it is, and are drawn on by an admiration of its beauty and harmony, to become themselves workers in its domain.

"Popular writers who hover upon its outskirts, describe to the world what they have seen, and the world judges science to be mainly destined as a handmaid to the industrial arts, and claims that as her highest use.

"Take as an illustration the report of the great Macaulay; he says that 'Bacon's philosophy aimed at things altogether different from those which his predecessors had proposed to themselves; that its object was 'to increase human comforts, to relieve more effectually the inconveniences of human life, to endow human life with new inventions and forces; that it 'began in observations and ended in arts.'

"Again: he says that a follower of Bacon, if asked what the new philosophy has effected for mankind, would name the prominent material results which have followed from it. 'It has lengthened life, it has mitigated pain, it has extinguished diseases, it has increased the fertility of the soil, it has given new securities to the mariner,' and so forth; but not one word of teaching a better use of human reason, or of showing the true helps to the human understanding.

"So truly does this represent the commonly prevailing opinion of this country, that experimental science is almost exclusively studied by those who wish to apply it to some technical purpose; and most persons would be surprised to hear that the most important of all the applications of science is to the business of general education.

"A brewer wishes his son to learn chemistry, because he knows that the quality of beer depends upon chemical processes which can be regulated by one who understands them. A dyer values the science upon similar practical grounds. But a schoolmaster, who has to watch the direct growth of young minds, and to supply each with the food best calculated for its development, is satisfied that the knowledge of a couple of dead languages and of mathematics, fully qualifies him for the work; and while admitting the utility for technical purposes of scientific studies, he usually ignores their educational value."

"A century has not elapsed since a discovery was made which must ever rank amongst the most remarkable achievements of philosophy. From the first dawn of human reason, the process of combustion had been an object of wonder not unmixed with awe. Men gradually learnt to obtain fire and to use it for various purposes, while the nature of the process by which it was maintained continued an impenetrable mystery to them. Various substances were found, such as wood and resin, capable of feeding a flame and of keeping it alive, but the fuel gradually disappeared whilst supporting the flame, and was supposed to be destroyed by the process. Powerful intellects strove to work out an explanation of the process of combustion, and gave words instead of facts. The process remained a complete mystery till experiment was brought to aid the reasoning powers.

"In the year 1774, Priestley obtained a gas by heating calx of mercury, as it was called. He found that combustible bodies burn in this gas with far greater intensity and brilliancy than they burn in common air; and that charcoal forms carbonic acid by burning either in air or in this gas. He declared it to be the active principle to which air owes its power of supporting combustion. We now know that combustion could not be explained without a knowledge of this gas, and that in reality Priestley's discovery supplied the key to the whole mystery.

"His mind was, however, so constituted as to discover facts by experiment, and not to discover their place in the order of nature. Priestley's energies were not devoted to explaining the process of combustion; he was a conservative in theory, and he called his wondrous gas 'Dephlogisticated air'—a name which was retained until the new theory of combustion suggested a better one.

"It was, however, not long before Lavoisier turned the discovery to account in his brilliant and masterly theory of combustion. He proved that this gas, which he named oxygen, unites with the materials of combustible bodies when they are burned in the air, and that the compounds thus formed contain the oxygen and the combustible materials.

"Combustion is a combination which gives off heat and light, but which does not destroy the elements taking part in it. If we burn wood or tallow or resin, and collect the products formed by their combustion, we can recover all the materials of the wood, or tallow, or resin, and the oxygen which had united with them.

"Those who know the wondrous light which this theory has thrown upon natural processes, and the vast amount of knowledge of the properties of transformations of matter which it has rendered accessible to us, cannot hesitate to class it among the most important results which man has yet attained.

"It enables us to understand, to classify, and to describe an infinite number of processes of change discovered by chemists; processes of which a few only have been explained in any other way at all, and those few in a most inconvenient and clumsy way.

"If we compare man's present insight into nature ('imperfect as it is) with that which he would have if this idea and its fruits were taken from him, it is like comparing daylight to the faint glimmer of starlight. We now see changes in the properties of matter which takes place when different kinds come together under particular conditions, and we learn how to regulate those changes by our knowledge of their nature and conditions, where formerly our uncertain glimpses gave us confused and very untrue impressions of destruction and production of different kinds of matter. We are delighted with a perception of natural forces working silently and irresistibly: and the more we observe and compare the results produced by these forces under various conditions, the more order and harmony do we find pervading the infinite variety of their manifestations.

"But while our power over matter has increased, we have become aware of its limits; for we now know that we can neither destroy nor create matter, only arrange, distribute, and alter its properties.

"Greatly as we must rejoice at these results, viewed as mere instruments of thought, they sink into comparative insignificance beside the method which led to their discovery, and which leads onwards to all future extensions of our knowledge. What made Priestley examine the properties of air itself and compare them with the properties of air in which a piece of charcoal had been burnt? What made him examine the gas given off by heating mercuric oxide or by heating nitre? He was cognisant of the facts and ideas established by previous investigators respecting combustion in air; and he put such questions to Nature as were suggested to him by a consideration of the results before him, receiving in reply facts of momentous importance. What made Lavoisier establish the theory of combustion by arranging Priestley's facts in natural order among other facts relating to combustion, and describing that order? Both men had the same materials of the thought before them, and both were interpreters of Nature; but two minds more different in their constitution could hardly have been, and two pieces of work more different than theirs can hardly be found. Priestley found the materials, but could not arrange or explain them. He could not even see the explanation when given by another. Lavoisier's chief merit was in arranging the facts given to him. He measured the amount of the changes which had been discovered, and his theory of combustion is the simplest statement of the result of a quantitative comparison of those changes. He had a genius for discovering order—Priestley had a genius for discovering isolated facts. The work of each harmonises with each other, and their very differences made them the more necessary to one another.

"Some persons might attribute this great result to chance (a common name for ignorance of causes); but those who ex-

amine carefully the course of discoveries and investigations prior to Lavoisier, will see that facts and ideas had been steadily accumulating for his theory; and that even if Priestley and he had not lived, others would doubtless have been led by the same laws of progress to make the discovery. Indeed it so happens that there lived in a little town of Sweden a quiet and modest man named Scheele, who, following quite independently the path of research, discovered oxygen nearly as soon as Priestley, and by a distinct process. Many a new truth was brought by that quiet honest man from the fountain head of knowledge, by the aid of the facts and ideas supplied by previous investigators.

"When we look back upon the work of that period, free and independent as the workers felt themselves to be, and various as were their aptitudes and peculiarities of mind, we see that in all parts of the field they were moving forward in the same direction, and helping one another by an involuntary division of labour. When we examine the work which has been done more recently, we see that the results of those great men have been used as instruments of thought by the latter workers, and gradually developed by further investigations, while new discoveries have been made and used in their turn as additional instruments of thought to extend still further our means of gaining knowledge. The first discoveries alone were within reach of the limited knowledge then available for experimental purposes, and they were needed for the latter work.

"The mind of man has only progressed and can only progress in a particular order. It must begin with the simple and rise gradually and slowly to the complex. The very attempts to deviate from this order only serve by their failure to prove its inevitable necessity.

"One other episode of modern history seems worthy of consideration. It is not many years since there existed among active chemists a difference of theory which was considered important. The difference was expressed by the words Type and Radical. Some explained compounds as built upon types, others contended that they were built up from radicals. Each party appealed to facts which favoured its own view, but neither party paid much attention to the facts quoted by its opponents. We now know that each party was right, except in its denial of the other statement. Each theory describes truly a certain number of facts, and a more general theory includes them all. Our present theory required the study of compounds from the point of view of radicals and also from the point of view of types, and they are, as it were, legs upon which our more general theory stands."

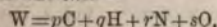
In the second part of his paper, published in the May number of the *London Student*, Professor Williamson points out some of the educational uses of experimental science.

CORRESPONDENCE.

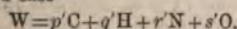
Organic Matter in Water.

To the Editor of the CHEMICAL NEWS.

SIR,—A little consideration of the action of permanganate of potash on organic matter will, I think, show the fallacy of the supposition that the quantity of a standard solution used is in direct ratio to the weight of organic matter present in water; unless we come to the unwarranted conclusion that the organic matter in water is homogeneous. Suppose two waters contain exactly the same weight of organic matter, W say, and that this weight is distributed among the elements carbon, hydrogen, oxygen, and nitrogen, in such a manner that, in the one case—

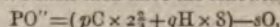


and in the second case—

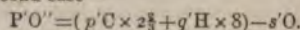


Suppose that the permanganate exerts its full oxidising action, so that all the carbon is changed into carbonic acid,

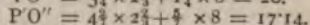
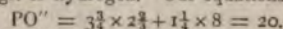
and all the hydrogen into water. Let O denote the quantity of oxygen required in the first case, and O' the quantity in the second. Then, if O'' denotes the quantity of oxygen contained in each measure of the standard solution, we shall have $PO'' = O$ and $P'O'' = O'$, where P denotes the number of measures used in the first case, and P' the number in the second case. We shall then have the following equations:—



and in the second case—



According to the permanganate method of estimation we should have the equation $P = P'$, and consequently $PO'' = P'O''$. A result which is very remote, and which evidently requires the extraordinary supposition that, whilst the total weight of organic matter remains the same, the four quantities vary so among themselves, that the quantity of oxygen consumed remains constant. For the sake of the simplicity of the example, suppose that the organic matter consist of carbon and hydrogen only, and that two waters contain each, in an equal bulk, 5 gr. of organic matter, distributed as follows:—In the first case, $3\frac{3}{4}$ gr. of carbon and $1\frac{1}{4}$ gr. of hydrogen; and in the second case, $4\frac{3}{4}$ gr. of carbon and $\frac{1}{4}$ gr. of hydrogen. Our equations would be—



Thus the number of degrees of permanganate used in the first case would be to the number used in the second, as 20:17; and it would be inferred that the quantities of organic matter were in this ratio, whereas the weights were equal. If, on the other hand, the permanganate of potash does not exercise its full oxidising power, but reduces the organic bodies present to forms of less complexity, it is evident no reliance can be placed upon an agent of such uncertain action.—I am, &c.,

JAMES BOTTOMLEY, B.A.

Queenwood College, near Stockbridge, Hants.

April 22nd 1868.

Permanganate as a Sanitary Water-test.

To the Editor of the CHEMICAL NEWS.

SIR,—Owing to the Easter holidays, I have been unable sooner to make answer to the remarks which have been addressed to me in the CHEMICAL NEWS, by Mr. Spencer and Professor Attfield.

To the former, I would reply that I was well aware of the fallacious indications which the presence of iron, in solution, in water may occasionally cause permanganate to give; but, as I was not recommending that substance for analytical purposes, but merely as a sanitary water-test, well suited for popular use, and did not pretend to give directions for its employment, and the correction of possible errors, I did not consider it necessary to allude to them. To prove, however, that I had not overlooked this source of fallacy, I will quote a passage from a communication of mine on this subject, which appeared in the *British Medical Journal* of the 15th of February last. "The presence of deleterious organic impurities in water," I said, "will rarely or never fail to be detected by the addition of permanganate solution. Other less dangerous or innocuous oxidisable matters, as iron, for instance, may no doubt occasionally cause a comparatively inoffensive water to be suspected of being hurtful; but it is barely possible that when really dangerous matter of organic origin is present, the permanganate will allow it to escape detection. It may leave comparatively untouched other organic matters, but these will assuredly be the more sound and stable substances which are incapable of producing the 'horrible results' that are sometimes occasioned by unsound and decomposing matters."

When iron is present in such quantity as to cause erroneous indications, it will usually be detected by the

palate. The taste communicated to water by even very minute quantities of iron, is one which most people would at once recognise. This source of error being known, nothing is easier, for a person possessed of only a smattering of chemical knowledge, than to determine whether the decolouration of the permanganate arises from iron. But the grand object of a popular water-test, so far as organic matter is concerned, is to afford the public a ready and simple means of detecting and rejecting water that may prove prejudicial to health. This the permanganate test satisfactorily accomplishes. If its use may sometimes lead to the temporary rejection, as unwholesome, of water charged with nothing worse than iron, the mistake will be on the safe side, and can never give rise to injurious results.

The popularisation of the permanganate test would assuredly tend to put an end to the occurrence of those outbreaks of fatal disease which are caused by the use of polluted water; and if this result were obtained at the expense of the occasional rejection of an innocuous water, it would be very cheaply purchased. But, what is more, the popular use of this substance would not only prove an effectual safeguard against those accidents to the public health which arise from the use of befouled water, but would afford the means of extemporarily purifying such water, and rendering it fit for consumption. Water that has been treated by permanganate will be found to be deprived of putrescible matter. Even repulsively foul water, after purification by this means, is not liable to become offensive. Permanganate solution, therefore, is not only of great value as a popular test for polluted water, but a safe and reliable means of freeing potable water from deleterious putrescible matter.

To Professor Atfield, I would reply that I am quite ready to admit that, instead of having proposed a new method of detecting organic pollution of water by the olfactory sense, as I, it seems, erroneously put it, he has merely suggested an improved means of rendering the nose a more efficient detective. As stated in my former communication, I consider Professor Atfield's suggestions on this subject well worth knowing, and I give that able chemist every credit for freely offering them to the general public. When he found fault with my letter in the *CHEMICAL NEWS* of the 3rd of April (*Amer. Repr.*, June, '68, page 288), for being similar to one which had appeared previously in the *Medical Times and Gazette*, he was not, perhaps, aware that the communication which called it forth had already appeared almost verbatim in another periodical.—I am, &c.,

J. MUTER.

Science Teaching in Schools.

To the Editor of the *CHEMICAL NEWS*.

SIR,—In the last number of this journal, your correspondent "D." (*Amer. Repr.*, June, '68, page 292) criticises some lectures of mine recently given at Eton College, and I feel constrained to offer a word in reply, although it is to be wished that the writer had given his name in full.

It would appear to be unwise to judge of the nature of a course of lectures from the concluding sentences of the last lecture, because a generalisation founded upon the assumption that the whole is similar to an infinitely small part cannot be very trustworthy. In the case in point, the small part differs materially from the whole, because the concluding portions of a course of lectures, to a greater or less extent, summarise the matter of the entire course, and usually give the more plausible and dominant deductions. A work on arithmetic may commence with simple addition, and end with affected quadratic equations; but it would be obviously an erroneous practice to deduce the nature of the whole book from its last chapter. As in the book, so in the course of lectures; we ascend from simple matters to those which are more difficult:—"Neque enim in plano via sita est," says Francis Bacon, "sed ascendendo et descendendo; ascendendo primo ad axiomata, descendendo ad opera."

"If we may judge of the lectures themselves," writes

"D.," "from these extracts, I would say that such lectures are not adapted to attract boys to science." Allowing for a moment, for the sake of argument, that the lectures may be judged of from the extracts (which I trust has been disproved above), I may say that I fully concur with "D." "that such lectures are not adapted to attract boys to science." They would not be fulfilling their object if they sought to do this; for if science, in its plain unvarnished form, does not present sufficient attractions to the student, it ill becomes the teacher to make it externally showy and factitiously attractive, while the reality must ever remain the same. It would be like binding a book, on say, Hebraic punctuation, in the same kind of binding as a popular novel. Those who require to be attracted to science by forced means can never study it with advantage, nor should we ask such to commence the study.

I do not mean to say that lectures on natural science should be sparsely illustrated by experiments: there should always be a sufficiency, and there is a limit in both directions. A lecture which is insufficiently illustrated is quite as bad as—one would say worse than—one which is over-illustrated; in the latter, there are so many experiments, that it is impossible to have them properly explained; in the former there is too much dry explanation, which could as well be acquired from a book. It is the happy mean that we all desire to attain. A lecture on natural science can rarely be sufficiently illustrated by less than fifteen experiments, and it is usually over-illustrated when the number of experiments exceeds twenty-five.

Because science happens to be popularized in certain places and in certain well known magazines, there is a general impression that it is to be viewed as an amusement, and that it does not require serious study and application to master it. Nothing can be more erroneous. Until this idea is disproved, natural science can never be taught in schools with advantage. If science is to be taught at all, it must receive from the pupil as much attention as he gives to Latin and Greek; it must not be regarded as an amusement or light study; notes must be taken, and themes must be written after each lecture, and a two-hour examination must be held at the conclusion of the course. Popular science is as much out of place in a school as popular Greek would be. To popularise a thing, is usually to degrade it. It is indeed right for us to rend the dark veil of the temple of nature, so as to expose the shrine to the worshippers without; but I think it is unnecessary to make the shrine garish with a false lustre.—I am, &c.,

G. F. RODWELL.

Estimation of Potash.

To the Editor of the *CHEMICAL NEWS*.

SIR,—With reference to the abstract of our paper on the "Estimation of Potash," which appeared in last week's impression (*Amer. Repr.*, June, '68, p. 284), we beg to state that on account of its requiring to be posted here on the evening following that on which it was read, we were unable to revise it.

Will you therefore kindly allow space for the following corrections in this week's issue, in order to prevent the necessity of any remarks or correspondence on the part of your numerous readers?—We are, &c.

THE AUTHORS.

Corrections.—Col. 2nd, line 10th from bottom (Col. 2nd, bottom line, p. 284, *Amer. Repr.*), read *sulphate of soda*. Col. 3, line 12 from bottom (Col. 1st, line 4th from bottom, p. 285, *Amer. Repr.*), read *hydric sulphate or hydric chloride*. Col. 3, line 17 (Col. 1st, line 26th, p. 285, *Amer. Repr.*), read *precipitates and evaporated washings*. Col. 4, line 12 (Col. 2nd, line 19th, p. 285, *Amer. Repr.*), read to dissolve the *pure potassic chloride*. Col. 4, line 13 (Col. 2nd, line 19th, p. 285, *Amer. Repr.*), introduce the following paragraph:—

"The method which we ultimately adopted for purifying recovered platinum, is that by reduction with alcohol and

excess of sodic hydrate, washing, boiling with hydrochloric acid, washing, drying, and simply igniting the resulting platinum black, and finally boiling with nitric acid and washing. This method invariably gives excellent results when the platinum solution is tried on pure potassic chloride." Col. 4, line 23, read, the authors object to the method of weighing small quantities (as 10 grs.) of dried salts. Col. 4, line 11 from bottom (Col. 2nd, line 4th from bottom, p. 285, *Am. Repr.*), read, 19313 and 1582493.

Death by Electricity.

To the Editor of the CHEMICAL NEWS.

SIR,—I perceive you have a paragraph on the above in your last number of the CHEMICAL NEWS (*Am. Repr.*, July, '68, p. 57), being an alleged new form of capital punishment, by a writer in *Harper's Weekly*.

I beg to inform you that I am the original proposer of the above; in June, 1863, I suggested to the Conservateur des Abattoirs à Paris, this method for slaughtering cattle; through insufficient address, this letter was returned to me by the "dead letter office" February 17th, 1865, you published my suggestion in the CHEMICAL NEWS, page 84 (*Eng. Ed.*).

In May, 1866, the Royal Society for the Prevention of Cruelty to Animals wrote to me that "they will be glad to appoint a deputation to attend any experiments I may desire to make, and that they will procure the permission of a butcher for the trial." This fell through because I had neither the apparatus nor the time to carry it out.

In 1866 I proposed this scheme to His Grace the Duke of Richmond, to be used instead of hanging, in capital punishment, conjointly with the suggestion that executions should take place in private, for which I gave my reasons why I considered it more expedient than the present mode. I also used the following words—"Simultaneously with the shock, the wretched being would pass into eternity without a pang."

I have condensed my letter as much as possible, and in conclusion beg a place in your journal, in common fairness to myself.—I am, &c.,

CHAS. N. ELLIS.

Wolverhampton, April 25th, 1868.

Professor Guthrie's Voltastat and Graphic Formulæ.

To the Editor of the CHEMICAL NEWS.

SIR,—The report which appears in your No. 438 (*Am. Rep.*, June, '68, page 275), of the meeting of the Chemical Society of the 16th of April is full, and in the main so accurate, that to those of your readers who were present on the occasion it might serve as a record.

As, however, you address a larger public, I beg you to allow me as concisely as possible, to clear away some misconceptions which seem to have arisen at the time, and which, judging from your correspondent "F.C.S." in the above number, have not been dissipated by reflection.

With regard to my voltastat, I have only two things to add to your report. The first concerns the use of the instrument as a voltameter. In order to calibrate the apparatus in the sense of determining the height of the mercury in the manometer tube, which corresponds to a given rate of gas delivery (or *vice versa*), it is necessary to collect the gases evolved. But, when this is once done, the height of the mercury in the manometer shows at once the activity of the battery. And here I think the instrument is of considerable value, because by a simple reading off we are able to arrive at a measurement of the strength of the current as accurate as that attained by the actual collection of the gas.

The second point, which is of some technical interest, is that raised by the President, who expressed his opinion that the voltastat was not applicable to weak currents such as are

required for the deposition of copper. I need only remind your readers that the tenacity of the copper film is not a mere function of the power of the battery, but also of the extent of the surface upon which the deposition takes place, and that the coveted state of aggregation of the copper is attained by extending the receiving surface, as well as by diminishing the strength of the current. *Ceteris paribus*, the deposited film is more coherent when the deposition takes place more slowly. Given a current of a certain strength—let the surface to be electroplated be exceedingly small, the copper deposit will crumble away as it is formed. Let now the current remain the same, but let the surface be extended, then in the same time the same amount of copper will be deposited, but being precipitated upon a larger surface it will be thinner;—the deposition will have taken place more slowly and the copper will be more tenacious.

From this cause alone the objection raised by the President would fall to the ground. But indeed no such extension of the polar surface is necessary. If a very weak current is required we have only to insert a tube of very small capillary opening. There is in fact no limit to the degree to which the strength of the current can be reduced by modifying the instrument.

The vivacious onslaught committed by Dr. Odling on graphic formulæ in general, and on Dr. Brown's especially, and of which a judiciously subdued account appears in your report, I would willingly leave for reply to Dr. Brown. But as the "humorous remarks" were called forth by my modification of Dr. Brown's scheme, I may be allowed a few words of reply.

In support of the use of graphic formulæ, I am fortunately able to cite an authority of whom I have no doubt Dr. Odling entertains a very high opinion. This authority is Dr. Odling himself.

In his "humorous remarks" Dr. Odling appeared shocked at the idea of an atom of nitrogen supporting three "sticks," one in each hand, and one on its head. Strange objection from one who years ago trained his atom of nitrogen to the much more difficult acrobatic feat of balancing simultaneously three sticks on the tip of its nose,—N."

Or would not our Secretary rather liken his accents to an advertisement on the part of the element? "Willing to adopt, three hydrogen babies, or an oxygen boy and a hydrogen baby, or a full-grown phosphorus adult. Apply to N., care of Dr. O., &c., &c."

In seriousness, I am far from wishing to depreciate the system of accents introduced by our humorous Secretary. But as formulæ constructed with them are to all intents graphic formulæ, I am at a loss to understand why the graphic formulæ introduced by Dr. Brown should have so terrified our Secretary that he has sought refuge from Dr. Brown's "sticks" even beneath the once detested "buckle" of Kolbe.

It is surely a misconception on Dr. Odling's part to imagine Dr. Brown's double bond to indicate a double strength of attachment; a misconception arising from a confusion between number and quantity.

I refrain from following Dr. Odling in his connubial illustrations, which combined great humour with considerable pathos.

Your correspondent "F.C.S." in the same number, arrives at the conclusion that there is little new in my scheme, and that that little is bad. Let me endeavour to reply to some of the remarks of "F.C.S."

Though my symbols for water and bromine resemble the ordinary symbols for division and multiplication, yet, since the latter operations are at present scarcely employed in chemical formalisation, there can be but little danger of ambiguity arising from this source. The dots and accents employed by Berzelius and others, for oxygen and sulphur may, perhaps, be still employed by "F.C.S.," but, I imagine, by few others. The resemblance between my symbol for oxygen and the minus sign can be of little consequence, because the minus sign need never be used.

I am fully aware that I am not the first to employ differently shaped figures to represent different elements. The hieroglyphics employed by the alchemists, and which still linger in pharmacy, are arbitrary. So are those mentioned by "F.C.S." The symbols whose use I suggest have a meaning. The novelty which I claim for my modification of Dr. Brown's scheme, is this:—The figures employed by Dr. Brown are, I think, difficult to read at a glance; the only graphic difference between the symbols for different elements being the number of linear attachments. The "atomicity" in my symbols is shown by the form of the symbol itself. I need only add that the sole reason I have for adopting these special symbols is, that they are the simplest I can find to express my meaning.

With regard to incompleteness, I fully admit the charge, and invite "F.C.S." to make the system more complete. As it stands, my plan is, of course, little more than a sketch; but, unimportant as it may be, it is for the consideration of chemists rather than of humourists.—I am, &c.,

FREDERICK GUTHRIE.

Edinburgh, April 28th, 1868.

Science Teaching in Schools.

To the Editor of the CHEMICAL NEWS.

SIR,—I cannot see that it was unwise to form a judgment on the tone of Mr. Rodwell's teaching from the published conclusions to two courses of his lectures, when each conclusion seemed to give the same indications. A teacher of science generally sums himself up in the final remarks of his course of lectures; and Mr. Rodwell appeared to have followed the usual custom.

As a matter of fact I could not understand the conclusions—I found them, in a marked degree, scholastic; I then inferred that a scholastic tone ran through the lectures, and from this, that they "were not adapted to attract boys to science." Mr. Rodwell objects to the mode in which I arrived at this conjecture, and then quoting it, adds—"they would not be fulfilling their object if they sought to do this;" hence it appears that they were not meant to attract, and it is an obvious probability that they were not adapted to attract.

However, I cheerfully concede to Mr. Rodwell that I am not in possession of sufficient material for forming an adequate idea of his lectures, and if I have misjudged him, I ask his forgiveness.

Setting particular schools and individuals aside, the imperial question remains—How is science to be taught in schools? If boys are to be elevated by means of science, it must of course be made a serious study; but, on the other hand, it should not be taught in the same hard, dry way in which classics have been taught. Phenomena should be explained simply, and I assert that the most talented and laborious teacher will not find his powers any too much for this. Theories that can be appreciated only by savants should not be introduced.

This is what I mean by the popularisation of science, and we want men to carry out this work. We do not want a temple to worship in, nor a haughty priesthood to exhibit to us a shrine; we want men who have been endowed with the means, leisure, and love for the work, to discourse to us in our own language on the works of nature, and to walk with us in the paths of real knowledge.—I am, &c., D.

Science Teaching in Schools.

To the Editor of the CHEMICAL NEWS.

SIR,—The difficulty for a conscientious lecturer on experimental science, seems to me to consist in his thinking himself obliged to go on from point to point with only a little reiteration, and with no oral questioning of his hearers. Grammar

probably requires more reiteration, more catechetical friction and raking, than physical science; but, to a certain extent, their demands must be similar. A teacher of grammar can do nothing without the frequent, sudden, lively interposition of questions; he cannot be satisfied that grammatical conceptions are formed in the learner's mind, except by seeing that the learner works under varied conditions. I imagine that a teacher of science ought to make sure that he is teaching, not merely by one examination at the end of a course of lectures, but by frequent catechetical examinations.

I sometimes sit amongst the young listeners to an experimental lecture: they have an infinite advantage over me in observing the experiments; but I have an equivalent advantage over them in recognising at once the terms used by the lecturer, by which they are often bewildered; and I long to stop him, and insist on his waiting till he is sure that they understand him. He assumes, I do not assume, that they at once recognise and understand such terms as "suspension," "solution," "inverse ratio," "refraction," "specific gravity."

It would be a robbery of precious time if he stopped to grind such conceptions into the minds of the ordinary boy: that is his view. Be it so: then there must be a division of labour. Let the demonstrator go on with his lecture: let the hack schoolmaster at other times teach the terminology; any cultivated man ought to be able to do this. We, who live with boys, and become, or remain like boys, know better than the lecturer knows their shoals and fogs of misconception, their power of forgetting, their innocent hypocrisy in assenting, with a look of intelligence, when they are really perplexed.

Unluckily, there are but few men who care to go over the ground that another man has ploughed, and pick out the weeds that he has left behind.

Having now and then done this for your respected correspondent, Mr. Rodwell, I recommend it as an ancillary department of that science teaching which is required of our schools.—I am, &c.,

WILLIAM JOHNSON.

Eton, May 5.

Chlorochromic Acid Test.

To the Editor of the CHEMICAL NEWS.

SIR,—This test, which is implicitly asserted by some textbooks and teachers to give sure and distinctive evidence respecting the presence of chlorine or a chloride, seems to me to fail in the case of $PbCl_2$, Hg_2Cl_2 , and $AgCl$.

In operating, I powdered and intimately mixed in a dry mortar about $\frac{1}{2}$ a grm. of each of these materials with double the quantity of neutral chromate of potassium; after drying the mixtures they were well moistened with strong, pure, warm H_2SO_4 , when there occurred no visible evolution of any vapour, either red or yellow; the silver mixture smelled feebly of chlorine.

Hence it appears that the chlorine in an insoluble chloride may escape detection by this method, and the process will only therefore be reliable after we have replaced bases furnishing such, by others (say the alkalis) which will admit of solution in the menstruum sulphuric acid.

Since both $BaCl_2$ and $CaCl_2$ yield abundant fumes of CrO_2Cl_2 on similar treatment, it would seem that the preceding instances of the failure of the test are not due to any insolubility of the after-products; but I must leave others to theorise.

Should there be any novelty (which I can hardly imagine) or utility in this observation of a student at the threshold of the gate of science, perhaps your impartiality will lead you to communicate it to others similarly situated.—I am, &c.,

B. W. GIBSON, M.A.

Eaton Square, May 13, 1868.

Science Teaching in Schools.

To the Editor of the CHEMICAL NEWS.

SIR,—I am glad to see that the important question, "How to teach Science in Schools?" is being discussed in your journal, since your readers are qualified, not only to understand the arguments advanced, but also to give reasons of their own in justification of their views.

Perhaps it may be allowed to one who has taught science in schools during five-and-thirty years, and is now about to retire, to give his views, so far as they can be expressed within the short space you can afford him.

The teacher should, I think, start from the fact that boys are good observers and bad theorists. They are fond of observing the habits of animals, and delight in anecdotes respecting them; they take every opportunity of witnessing and performing experiments, not forgetting those of the fifth of November; their tops, marbles, kites, and squirts, to say nothing of cricket and racket, are all experimental, and gratify their love of active observation. I don't know how it is, but as boys grow up into men, they become worse observers, and not always better reasoners. But taking it for granted that boys love experiments, and hate the explanation, we have, I think, a clue to the nature of the boy's mind and the mode of operating upon it in the way of scientific teaching.

The lecturer ought, according to my view, to adhere strictly to the Baconian, or if you like, to the Comtean method of dealing only with phenomena and their laws. Let him say nothing of theory: let him avoid the causes of things, and not seek for the origin of light and electricity: let him avoid all those subtle notions connected with heat, and the convertibility of force: let him eschew molecular motions and molecular changes, and never give as a law what is only an hypothesis.

I know it is difficult to do this, because our knowledge advances by trying what we suppose to be true by what we know to be true. This is fair work for societies, transactions and journals; but it should be carefully kept out of schools. There is a vast, but pleasant field for the earnest teacher to travel over with his pupils, if he strictly confine himself and them to the laws of phenomena.

Science is constantly engaged in solving three great problems—1st, given the phenomena to find the law; 2d, given the law, and some of the phenomena, to find those quantities which are to serve as *data* for the prediction of other phenomena; 3d, given the law and these data to foretell the phenomena. Now it is the first only of these problems that can ever be completely solved, and it is this only that we should introduce into schools. If this be well done, it will lead a few out of many boys to seek out at a later period the means for following up the other two. They may even do so to some extent while at school, if the mathematical master happen to sympathise with experimental science.

The lecture should be experimental; only the simplest numerical data being used. The leading points should be exhibited in clear writing on a large sheet of paper. The lecturer should guide his class in the difficult art of taking notes, and every boy should send up a written account of each lecture. This will not only tend to fix the teaching, but will give the boy a wholesome exercise in writing English about what he knows, instead of the ordinary subject of themes, such as "love of country," &c., of which he is ignorant.

If the written accounts are too numerous, the masters of the school may assist the lecturer in reading and correcting them. The lecturer should be deliberate and distinct in his utterance, and avoid eloquence with as much horror as a sensible man avoids fine writing. Moreover, he should encourage his pupils to ask questions, and to request the repetition of such or such an experiment.

Much more might be said, but as I do not intend to trouble you with a long letter, I conclude.—I am, &c.,

C. TOMLINSON.

King's College, May 16th, 1868.

Names Versus Symbols in Text-Books.

To the Editor of the CHEMICAL NEWS.

SIR,—As you have opened your columns to letters upon the difficult subject of teaching science, I beg to be allowed space for a few remarks upon the *Names versus Symbols* used in the text-books on chemistry recommended to beginners.

It may be taken for granted that what is generally understood as the binary theory of salts is the one adopted in this country to express the composition of chemical compounds. That this theory is imperfect we are all doubtless well aware, but at the same time its imperfection is of no consequence in practical teaching, since it is consented to by chemists because it is as good and useful a theory as any with which we are at present acquainted. I take the chief point in this theory to be, that the symbolic representation of all chemical compounds shall be analogous to that of common salt—NaCl.

If the above be true it is the duty of every teacher of chemistry, to endeavour by all the means at command, to suit his nomenclature and method to the theory he is about to communicate.

Are the text-books, or rather is the nomenclature they contain, in thorough accord with the theory they profess to teach?—I think not.

The reason why they are not, is, I believe, in great measure due to the fact that writers of text-books and teachers of the science have never worked in unison; have never come to any kind of agreement as to the terms best adapted to express certain facts. Each has taken his own view of the subject, and written what seemed sufficient to suit his own purpose. They have never, I think, duly considered the influence of old ideas upon persons who do not make chemistry their chief study, nor have they clearly stated the entire change which has taken place. Thus we have a mixed nomenclature, giving rise to conflicting notions upon what, whether right or wrong, should be distinctly stated.

I do not propose to lay before you anything new, neither do I pretend to unfold any panacea for our evils; I am fully alive to the difficulties of the problem I wish to solve, and am aware that many great and scientific men are, and for a long time have been, occupied with the revision of our nomenclature, and it is only my long and sad experience in teaching, which induces me to venture in bringing the subject before you.

There can of course be no objection to a chemist using any system of nomenclature in a scientific paper intended for chemists, or to the employment of any formulae, not excepting the graphic, or even to his mixing different names and formulae for the same substance; but in a text-book intended for beginners, we ought to confine ourselves rigidly to one, and heaven knows the labour of teaching only that one, to the generality of students.

The particular terms in our nomenclature to which I wish to draw attention, are those of acid, base, salt and radical.

Our idea of acid is borrowed from the taste of vinegar and unripe fruit; it has grown up with us from the nursery, and is an inheritance carrying with it its own lesson and associations. In chemistry, do we teach boys that all acids are sour? Certainly not. Do we mean to state that an acid is a body capable of uniting with a base to form a salt?—Certainly not! Do we mean to state that an acid is a body possessed of diametrically opposite properties to a base?—No. But many boys cling most pertinaciously to the idea, that lump sugar is the great representative of the class of bodies called bases. Do we imagine that mere words are sufficient to make a boy believe that flint is an acid, or that water is a most potent and active dibasic acid?—We may try, but we don't succeed. The only way to convince him is, in the laboratory, to melt a carbonate, and when it is calmly fusing to add dry flint, and show him the escape of carbonic acid, and even then while admitting the fact he does not believe you, but says "you call it an acid." Again, water, which far more deserves the name of acid than flint,

does not receive that appellation. It is only hinted at occasionally and indirectly in our text-books. But if H_2SO_4 is a bibasic acid, because it has two proportions of replaceable H; then H_2O is a dibasic acid for the same reason; and if H_2SO_4 is to be called dihydric sulphate on account of the two proportions of replaceable H, then H_2O is dihydric oxide for the same reason.

But who, in a laboratory, would ever dream of asking his fellow for the dihydric sulphate; or tell his pupil to add an additional proportion of distilled dihydric oxide to his solution, &c., &c.? If, then, from old association, we never apply these new names in practice, ought we not to do our utmost to save beginners from the danger of receiving wrong ideas? Now, it is granted on all hands, that to give exact principles to beginners you must use clear and definite language, thus supplying them, as far as possible, with correct means from which to form those ideas; and further, that until you get a youth to think chemistry in correct terms, you cannot expect him to produce exact answers; and even when correct terms are given, I am afraid, from past experience, it is hopeless to expect a boy to use them unless he finds others doing so too.

In our class-books we find such a term as dihydric sulphate given to the body H_2SO_4 ; but in the same page it is called sulphuric acid, and in a third place, oil of vitriol. So, also, authors who adopt hydric chloride as the proper name for HCl , almost invariably in the text write about hydrochloric acid. Is it fair to ask a boy in his reading to think in such terms as hydric chloride, and to be examined in them, while in his text-book, and in the laboratory, he has practically never heard it called anything but hydrochloric, or even muriatic acid. These names matter nothing to the chemist, neither do the formulae, whichever, say of the 20 recognised ones, you choose to use for common vinegar. The chemist would most likely know what you meant, without caring much for your names or symbols; but not so the boy, or the beginner. To such a one, a name means something, and a formula is supposed by him to be a sort of representation of the composition of a body. He requires therefore, first, a formula for vinegar to be given without comment that it is wrong, or that there are 19 others, all of which, according to their authors, are more correct than the one he is learning. Further, all the recognised text-books should give the same recognised formula for the same body, leaving it to more advanced books to deal with the differences of opinion respecting them. If boys are to believe in chemistry, they must find the same names and the same facts recorded in all their text-books; and this at present is not the case. It is therefore proposed, for the consideration of all persons who have the school-teaching of chemistry at heart, whether it would not be better to exclude altogether the terms acid and base from elementary text-books.

Should you, Sir, deem these remarks worthy of a place in your valuable Journal, I shall be happy, at some future time, to consider the other terms, namely, salt and radical.

The present letter is, I fear, already too long to discuss them now.—I am, &c.,

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Science Teaching in Schools.

To the Editor of the CHEMICAL NEWS.

SIR,—The excellent letter of Mr. Tomlinson in your Journal of May 22nd (*Am. Repr.*, July, 1868, page 53) must be my excuse for troubling you with a few lines upon the subject of Science Teaching in Schools.

I have, on the average, 150 pupils going through the courses of chemistry and physics necessary for the various competitive examinations during each six months, and as each member attends two lectures in the week, I may

perhaps be allowed, after nearly seven years' experience, to add my tribute to Mr. Tomlinson's assertions.

It is, in most cases, next to impossible to impart the theories for the production of heat or electricity, for example, to any except the senior divisions; and I most cordially agree with Mr. Tomlinson, "to say nothing of theory," except in special cases where the mind is well prepared by age and previous scientific training in lower classes to receive such impressions. I believe the true system to be, (1), gradually to rear the mind of the young student, commencing, for example, with the most elementary considerations of pneumatics and general properties of matters. (2). He should, as Mr. Tomlinson justly observes, be thoroughly instructed in that most difficult process of taking notes, and particularly of each experiment, and in some cases made to draw the essentials of the apparatus used. (3). A *visu voce* examination should be held upon the subject of the previous lecture; this I believe of great good, for by it you find out the weak points of which nine out of ten pupils are for some reason or other ashamed to tell you; and in junior classes it is well to invite questions after every experiment. (4). Scientific terms should be avoided as far as possible at the commencement, and even when they are used should be most thoroughly explained.

A course of elementary technology, such as our leading manufactures, illustrated by specimens and diagrams, and experiments when possible, I find of much value and greatly appreciated.—I am, &c.,

T. BLOXAM.

The College, Cheltenham.

MISCELLANEOUS.

Technical Education.—We think the CHEMICAL NEWS may be justly proud of the fact that it was the first journal to introduce the subject to the English reading public. The question has been warmly taken up both by the medical, weekly, and ordinary daily papers, numerous articles have been written upon it, and a number of scientific gentlemen have formed themselves into a committee for advocating its adoption in England. For this really very considerable amount of progress we have to thank mainly the British Association for the advancement of Science; and if a scheme is promptly drawn up and as promptly carried out, for the fulfilment of the objects in view, the credit resulting to the Association will be one of the greatest in the series of its already great triumphs.

The public must do scientific men the justice of acknowledging that they have not been slow on their part in urging this matter. The result of its neglect every one now admits to be most disastrous; let us not, therefore, wait for something worse by letting these questions now die out by want of discussion. The recognition of a defect is the first step towards its remedy, and that the recognition has been given any one may judge from the daily press; we quote the following from a publication of great promise, *Beeton's Journal*, which is intended to obtain, and we believe has already done so, a wide circulation among the boys of our large colleges and schools:—

"However soon we may set technical schools going, we cannot bring the knowledge so acquired to bear for many years. Our hope must be in the rising generation of Englishmen. They should think, *think* over these mechanical arts; they should view them as a noble study. Every fresh labour-saving machine means another class of men raised from degrading toil to healthy independence; from a position where the mind is robbed, it may be, of all chance of improvement, to one where the mind is employed and the body saved. And it means, moreover, a new source of wealth to the country, and a new vantage-ground over foreign states.

"If the spirit of the great inventors is to slumber through the rising generation, then, when our great men do arrive, we shall probably be too far behind in the race to make good

our lost ground. But this ought not to be. The new generation sees the works of the giants of other days; it reads of their doings. It has not the same fear of leaving their beaten paths, of departing from their practice, which may be supposed to have deadened the inventiveness of the pupils of the great men themselves. There are great things waiting to be invented. There are fame and wealth to be won. But we want something altogether new and wonderful, something to set our hearts beating as our fathers' beat at the electric telegraph, not to set our brains calculating the dividends to be made by sending messages, something grand, and with an interest apart from money."

It should not be forgotten that the question of technical education for workmen and their employers must be regarded as inseparable from that of scientific education; in the higher classes of society, the one without the other is quite valueless. It may be freely granted that technical education is encouraged abroad and neglected at home; the evil result is admitted to be of magnitude; but few results of this kind are due to one cause only—and a further cause, and in the main, not a less effective one, is the want of recognition that is awarded socially and politically to men of science generally. Science requires support by state grants, parliamentary representation, and introduction into schemes of general education, for its proper development in England. It is sufficient merely to indicate the ground that should be taken up by all scientific men, and we have endeavoured to supply them in this journal with the materials necessary for a clear expression of facts as they stand. When such materials are afforded as data, we can safely omit all comparisons, and there need be no fear that the verdict of all thinking men will be otherwise than a unanimous one.

We begin, then, with the report that has been drawn up by Dr. Bahin upon the technical schools of France; we only wish that there existed in England an official blue book drawn up by competent commissioners.

"Of the many institutions in France devoted to technical education, the *Ecole Centrale des Arts et Manufactures* stands highest. It enjoys a world-wide reputation, as pupils flock to it from all parts of the civilised globe. It was founded in 1829 by a private Society of eminent scientific men, for the purpose of training civil engineers and managers of industrial work and manufactories. It has well sustained its reputation; from a private it has gradually risen to the importance of a national institution, by raising industry to the rank of the liberal arts, and by creating, as it were, a new faculty. The instruction provided here is not only theoretical, but eminently practical, as most of the professors are former pupils of the school, who, after devoting many years to practical work, return with this additional experience, to carry out those sound methods of instruction under which they themselves were formed. The pupils of this school are not all drawn from the richer classes, but are to a certain extent recruited from the workshops. The principle of assisting poor but deserving students forms a striking feature in its organisation. I quote the following words from the prospectus:—"To give to a young man, poor but talented, the means to develop his faculties, to endow the country with an industrious man who will know how to draw fresh wealth from it, is not only a good action, but a good investment." The government, the local authorities of the departments, and the *Société d'Encouragement*, have each contributed towards this noble work. The course of study extends over three years. Candidates for admission are required to pass satisfactory examination in elementary mathematics and composition. The studies of the first year are general and obligatory upon all pupils. They form a suitable preparation for the succeeding years, and enable each pupil to select the special branch of industry for which his taste and capacity best adapt him. The selection must be made at the beginning of the second year. The studies are then divided into four sections—1. Machinery; 2. Physical science; 3. Chemistry; 4. Mining and metallurgy. The pupils undergo special examinations during the year, and a general one at the end of each year, which serves to determine their fitness for passing

from a lower to a higher grade. Those who at the end of the course satisfy all the examination tests receive diplomas, and those who satisfy only a certain number receive certificates of capacity. These diplomas and certificates are the sure introduction to honourable and lucrative employment, affording thus a valuable criterion of the estimation in which the school is held, and of the importance of the work which is done in it.

Next in importance are the *Ecoles Impériales des Arts et Métiers* of Aix, Angers, and Châlons. These are essentially Government schools, established for the purpose of training foremen and managers of workshops and skilled artisans. Each school draws its pupils from a certain number of departments, of which it is the centre. Applications for admission must be addressed to the prefect of the department in which the candidate resides, accompanied by certificates of birth, health, good conduct, and general aptitude for some mechanical labour. Admission is obtained only after passing two examinations. The first is both oral and written, and comprises reading, writing, arithmetic, elementary geography, geometrical drawing, and the drawing of ornament; and, in addition, each candidate is required to execute some piece of work in wood or iron, in connection with the trade which he has been learning. The second examination is entirely oral, and limited to the subjects of the first. The following details are worthy of note:—Pupils are received only as boarders, at an annual payment of twenty-four pounds. The parents of poor but successful candidates, on addressing a formal application to the minister, are exempted from paying either the whole or a certain proportion of this sum, according to their means. The course of instruction extends over three years, and is both theoretical and practical. The former comprises arithmetic, algebra, trigonometry, descriptive geometry, mechanics, drawing, and grammar. The latter is carried on in four workshops, and includes carpentry, smithery, casting, and fitting. Prizes are awarded at the end of each year to the most deserving pupils, and certificates at the end of the course to those who acquit themselves satisfactorily; and, if any specially distinguish themselves, they receive in addition a silver medal. In the eastern departments of France, which abound in manufacturing industry, the benefits of technical education have been widely extended. At Mulhouse, one of the principal centres, there are several important schools, founded and maintained by the munificence of the leading manufacturers.

The *Ecole Professionnelle* renders valuable services to the cause of industrial progress by the variety and extent of its educational programme. It comprises five divisions—1. An elementary division, in which languages, mathematics, and the principles of science are taught. 2. A special division, where, in addition to the higher branches of the above subjects, practical science is taught in the workshops, under the direction of an engineer and two foremen. 3. A commercial division. 4. An industrial division, where the instruction is chiefly practical, and carried out in the workshops, the chemical laboratory and the schools for spinning and weaving. 5. An upper division, serving as a complement to the second and fourth divisions, and preparatory to the *Ecole Centrale*. In the practical department of dyeing, printing, spinning, and weaving, the pupils are initiated into all the most recent improvements, and, under the guidance of an experienced professor, they pay periodical visits to all the great industrial establishments in the neighbourhood. There is also a special school at Mulhouse for teaching the theory and practice of power-loom weaving, established under the patronage of the Industrial Society. The school was called into existence for the express purpose of stimulating improvement in this branch of industry. Connected with it is a complete working establishment, to which the pupils are admitted, only after the satisfactory completion of their studies, either as working weavers or overseers. This establishment also becomes a valuable medium between inventors and manufacturers, by undertaking to examine and report upon all new inventions and improvements brought before it, and by helping to secure

their immediate adoption in all cases where their merits are duly recognised.

No sketch of technical education in France would be complete without some notice of the Conservatoire des Arts et Métiers. This is a vast museum of the accumulated industry of the country, and in connection with the Exhibition merits a very careful inspection. The principal objects in the collection are models of the tools and operations employed in almost every trade; models of building construction, machinery and engineering; also models illustrating all sorts of manufacturing processes, such as the working of iron and the reduction of metallic ores. The collections of physical and chemical apparatus are very valuable, and serve to illustrate in a remarkable degree the progress of scientific discovery.

Silvering Glass Mirrors.—The process we propose to describe has for its author Prof. Henry Draper, of this city, and may be divided into five operations, viz., the cleaning of the glass, the preparation of the silvering solution, the warming of the glass, the process of silvering, and the polishing. The description is for a 15½ inch mirror. 1. Rub the glass plate thoroughly with aquafortis and then wash it with plenty of water and set it on edge on filtering paper to dry; then cover it with a mixture of alcohol and prepared chalk, and rub it in succession with cotton flannel. 2. Dissolve 560 grains of Rochelle salt (tartrate of soda and potassa) in 2 or 3 ounces of water, and filter; dissolve 800 grains of nitrate of silver in 4 ounces of water. Take an ounce of strong ammonia of commerce, and add nitrate solution to it until a brown precipitate remains undissolved. Then add more ammonia and again nitrate of silver solution. This alternate addition is to be carefully continued until the silver solution is exhausted, when some of the brown precipitate should remain in suspension. Filter. Just before using, mix the Rochelle salt and add water enough to make 22 ounces. The vessel in which the silvering is to be performed should be a circular dish of ordinary tin plate, and coated with a mixture of equal parts of beeswax and rosin. At opposite ends of one diameter two narrow pieces of wood are cemented to keep the face of the mirror from the bottom of the vessel. 3. The glass is slightly warmed by putting it in a tub or other suitable vessel and pouring in tepid water to cover the glass; then hot water is gradually stirred in. 4. Carry the glass to the silvering vessel, into which the silvering solution has been poured, place the whole apparatus before the window and keep up a slow rocking motion. Leave the mirror in the liquid 20 minutes or half an hour, and wash with plenty of water. 5. When the mirror is perfectly dry, take a piece of the softest buckskin, stuff it with cotton, and go gently over the whole silver surface to condense the silver. You may use some of the finest rouge. The best stroke is a motion in small circles; rub an hour. The thickness of the silver thus obtained is about 1-200,000th of an inch.—*Scientific American*.

Caution to Bakers.—On Friday, April 24th, at the Winchcombe Petty Sessions, before the Rev. R. Wedgewood and J. Waddigham, Esq., county magistrates, George Smith, baker, was summoned at the instance of J. C. Dent, Esq., for having adulterated his bread with alum. The charge was clearly established by Mr. Horsley, of Cheltenham, county analyst, who made a series of interesting experiments, the result of which was that the defendant was convicted, and fined £8 and costs, including the analyst's charges.

New Training College for Veterinary Students.—It is proposed to start a New Training College in September next under the presidency of Professor Tasson. This College will be founded for the purpose of supplying an admitted want, namely, an institution in which youths intended for the professions of Veterinary Medicine and Agriculture can be furnished with that preliminary general and scientific education which is so highly essential—1stly. To enable them to quickly comprehend the technical terms employed in the various branches of Medical and Agricultural Science, to follow the reasonings of lecturers and authors, and therefore

to readily and thoroughly master the subjects which engage their attention while pursuing the advanced and professional courses of study taught in Veterinary and Agricultural Colleges. 2ndly. To enable them to grasp principles, to appreciate their value, and to acquire the power of applying them with facility in the practice of their professions. 3rdly. To enable them to raise the dignity and increase the importance of their callings, and to fit them for occupying that social position which is allotted to every educated man. The curriculum of study will comprise English, Arithmetic, Latin, French, Geometry, Algebra, Zoology, Botany, Physics, Chemistry, and Practical Chemistry. For the latter purpose a laboratory will be provided, in which instruction will be given in the rudiments of Analytical and other branches of Experimental Chemistry. The curriculum is so arranged that youths of average ability and industry may pass through it in one session. The session will be divided into three terms.

Royal Institution of Great Britain.—At the annual meeting, held on Friday, May 1, 1868, W. Poole, Esq., in the chair, the annual report of the Committee of Visitors for the year 1867 was read and adopted. The books and pamphlets presented in 1867 amounted to 131 volumes, making with those purchased by the managers, a total of 319 volumes added to the library in the year, exclusive of periodicals. Forty new members were elected in 1867. Sixty-three lectures and twenty evening discourses were delivered during the year 1867. Thanks were voted to the President, Treasurer, and Secretary, to the Committees of Managers and Visitors, and to the Professors, for their services to the Institution during the past year. The following gentlemen were unanimously elected as officers for the ensuing year:—*President*—Sir Henry Holland, M.D., Bart., D.C.L., F.R.S. *Treasurer*—William Spottiswoode, Esq., M.A., F.R.S. *Secretary*, Henry Bence Jones, M.A., M.D., F.R.S. *Managers*—Henry Wollaston Blake, Esq., M.A., F.R.S.; Charles Brooke, Esq., M.A., F.R.S.; Adm. Sir Henry John Codrington, K.C.B.; Captain Douglas Galton, C.B., F.R.S.; John Peter Gassiot, Esq., F.R.S.; William Robert Grove, Esq., M.A., Q.C., F.R.S.; Cesar H. Hawkins, Esq., F.R.S.; Sir John Lubbock, Bart., F.R.S., Pres. Etom. Soc.; Sir Roderick I. Murchison, Bart., K.C.B., D.C.L., F.R.S.; William Poole, Esq., M.A., F.R.S.; William Frederick Pollock, Esq., M.A.; Robert P. Roupell, Esq., M.A., Q.C.; Lieut.-Gen. Edward Sabine, R.A., D.C.L., Pres. R.S.; Sir Charles Wheatstone, D.C.L., F.R.S.; Colonel Philip James Yorke, F.R.S. *Visitors*—Andrew Whyte Barclay, M.D.; Charles Beevor, Esq., F.R.C.S.; John Ashton Bostock, Esq.; John Charles Burgoyne, Esq.; Rev. Charles Fynes Clinton, M.A., F.R.S.; Alfred Davis, Esq.; William Dell, Esq.; Rev. G. Codwin Pownall Glossop, A.M.; Alfred Gutierrez Henriques, Esq.; Edward Henry Moscrop, Esq.; William Newmarch, Esq., F.R.S.; Arthur Giles Puller, Esq., M.A., F.S.A.; Samuel Scott, Esq.; Edward Owen Tudor, Esq., F.S.A.; Robert Ballard Wood, Esq., F.S.A., F.R.B.S.

Galvanic Action of Copper-Bottomed Ships in Dock.—The *Elk*, 2, twin-screw (composite-built) gunboat, 465 tons, 120-horse power, launched during the past winter from Portsmouth Dockyard, and subsequently fitted with her engines and boilers, was placed 10 weeks since in the old shipping-basin of the yard, to wait there the finishing of her pair of screws, which were ordered to be cast from enlarged patterns. On Tuesday last she was taken out of the basin again and docked to receive her screws, which had in the meantime been completed for her. On attempting to clean the ends of the shafting, however, to receive the screws, it was discovered that galvanic action had been at work to such an extent that the "key" pieces on the shaftings were reduced to plumbago, and other parts of the metal "honey-combed." The fact appears to be that the small area of water in the old ship basin is but seldom open to the admission of the tide, has always three or four copper-bottomed vessels floating upon it, and is, therefore, a chemical bath, whose power has been so unexpectedly, yet convincingly, displayed upon the screw shafts of the *Elk*.

The Royal Society.—At the meeting of this Society last evening, the names of the 15 candidates whom the Council recommended for election into the Society were read from the chair. The only chemists in the list are—A. V. Harcourt, Esq., and P. Griess, Esq.

Electric Light.—Some recent correspondence between the Trinity-house and the Board of Trade shows that the electric light at Dungeness can now be worked by either of the two engines, so that no disturbance occurs when one requires repair. The services of the high-class engineers and firemen have been dispensed with, and the Elder Brethren have since been enabled to do that which the connexion of the men with the trades union prevented—viz., to have their own ordinary keepers trained to drive the engines, as well as to attend to the lamps, a steady old experienced keeper being placed at the head of the establishment. The magneto-electric apparatus shown at the Paris Exhibition presented several improvements. The working by either of two machines showed that the power or the light can be duplicated in thick weather; and the engines were utilized for working the pumps of an air fog-trumpet. The electric light was compared with the flash of a first-order revolving oil apparatus belonging to the French authorities; and at 15 miles' distance the Trinity-house engineer, Mr. Douglass, estimated the power of the fixed electric light at twice that of the flash of the oil light. The superiority of penetrating power of the electric light in fog was shaken by some experiments made by the Royal Engineers, but it turned out that this result, so different from all other experience, arose from a settlement in the wood-work supporting the electric lens, causing the lens to be out of its proper position. Since the alterations made at Dungeness, the light there has worked with great regularity and efficiency; and the Elder Brethren have proposed to place similar lights at the South Foreland, Lowestoft, and Souter Point. The Board of Trade approve the extension of this mode of illumination to the South Foreland and Lowestoft, but at present suspend their decision respecting Souter Point. The Committee of Elder Brethren who attended at the Paris Exhibition say: "As far as the eye is a test, the power of the English fixed light was considerably in excess of the French, and when both machines were in use, and there was a good current, the fixed beam of the English light did not contrast unfavourably with the revolving one of the French, the flash of which is of great power. The contrast of the electric fixed light with the French first-order oil dioptric revolving light was very marked: indeed, the one may be said to put the other out. But the most beautiful feature of the electric was the extraordinary beam it gave. It shone night after night, large, steady, and lustrous as a planet, and you could see in the darkness a beam passing as far as the eye could see. From the tower, with the light at our back, it was very marked, and quite lit the hills round Paris. The whole horizon in the plane of the light showed the white beam, and at the distance of four miles it shone upon the windows of some houses, making them appear to be lit up. By extinguishing and relighting quickly several times this was very plain. Altogether the light was very remarkable, and the committee are glad to be able to report such an advance as the powers of the light show over that at Dungeness; indeed, the latter gives to the observer no conception of what the present one is, and it is satisfactory to know that the result of five years' work and observation, with imperfect and ill arranged apparatus, has now borne such good fruit, and that as England was the first to test and adopt this adjunct to the sources of lighthouse illumination, so she still retains her superiority. It is due, however, to Mr. Holmes to say that great as are the improvements already effected, he states that he is confident he can yet greatly increase the illuminating power before the present apparatus is re-erected at a permanent station."

A Telegraph Feat.—At an early hour this morning

(Feb. 1) the wires of the Western Union Telegraph Company from San Francisco to Plaister Cove, Cape Breton, and the wires of the New York, Newfoundland, and London Telegraph Company from Plaister Cove to Heart's Content, were connected, and a brisk conversation commenced between these two continental extremes. Compliments were then passed between San Francisco and Valentia, Ireland, when the latter announced that a message was just then being received from London direct. This was said at 7.20 a.m., Valentia time, Feb. 1. At 7.21 a.m., Valentia time, the London message was started from Valentia for San Francisco; passed through New York at 2.35 a.m., New York time; was received in San Francisco at 11.21 p.m., San Francisco time, Jan. 31, and was at once acknowledged—the whole process occupying two minutes actual time, and the distance traversed being about 14,000 miles! Immediately after the transmission of the message referred to, the operator at San Francisco sent an eighty-word message to Heart's Content in three minutes, which the operator at Heart's Content repeated back in two minutes and fifty seconds. Distance about 5,000 miles.—*N. Y. Journal of the Telegraph.*

Aluminium Bronze.—M. Evrard, in order to manufacture aluminium bronze, does not combine copper and aluminium directly together. He makes use of a kind of pig iron containing aluminium. This is slowly heated to fusion, when copper is added to the melted mass. Aluminium, having more affinity for copper than for iron, abandons the latter and combines with the copper. After the entire mass has been well stirred it is allowed to cool slowly, so as to permit the aluminium bronze, which is denser than iron, to find its way to the bottom of the crucible. The same process may be employed, according to the author, to obtain a bronze of silicium. Indeed, the affinity of copper for silicium is energetic enough to induce M. Evrard to try this method for separating silicium from pig iron by adding a proper quantity of copper.—*American Artisan.*

Death by Electricity.—A writer in *Harper's Weekly* recommends a new form of capital punishment. The method is "death by electricity." He says: "It is perfectly painless and absolutely instantaneous." Another writer says:—"Why is not this in every way preferable, and a thousand times less shameful to a civilized people than the slow strangling now practised upon our criminals?"

Alcohol from Wood.—In the process of making paper from wood, round disks of wood are first subjected to the action of hydrochloric acid to dissolve out the spongy cellulose. This latter has, until lately, been a waste product, but is now converted into alcohol in this way. The wood is boiled for twelve hours in hydrochloric acid, diluted with ten times its volume of water. The acid liquid, which is charged with grape sugar formed from the spongy cellulose, is then withdrawn, the excess of acid saturated with lime or chalk, and a small quantity of yeast is added, the temperature being kept at about 68° Fah. Fermentation soon ensues, and when bubbles of carbonic acid gas are no longer evolved, the liquid is distilled to obtain the alcohol.

Phosphorus in Iron.—The remarkable deteriorating effects of phosphorus in iron furnish a curious and striking illustration of Lord Palmerston's definition of "dirt"—*matter in the wrong place*. The *Colliery Guardian* says: "The phosphorus in Cleveland iron, which so seriously reduces its value in the market, and renders it necessary to bring iron from other districts to mix with the iron of the district in the puddling furnaces, and to use the ores of other districts to mix with its own—would, if extracted, even in its lowest priced form—as a manurial ingredient—be worth at least £66 per ton; as one ton of phosphorus is equal to 2 tons 5 cwt. of phosphoric acid, or 4 tons 10 cwt. of the highest qualities of Patagonian, or seven tons of Peruvian

guano. There is therefore a tolerably good margin for working expenses, if the process by which the phosphorus is extracted is carried out on tolerably economical principles. For instance, iron which is now worth 47s. per ton, when containing one per cent of phosphorus, would, if freed from this element, be worth at least as much as hæmatite iron, or say 54s. per ton."

British Association for the Advancement of Science.—The meeting for the present year will commence in Norwich, on Wednesday, the 19th of August next, under the presidency of Joseph Dalton Hooker, Esq., F.R.S., D.C.L., &c., Curator of the Royal Gardens at Kew. The fact that Norwich has never before been visited by the British Association, the character of its manufactures, the highly interesting geological features and archaeological remains in the surrounding district, with a hearty desire worthily to receive the Association, will combine, we trust, to make the meeting thoroughly interesting and successful. Through the liberality of various public bodies and private individuals, the Committee have obtained excellent accommodation for the various meetings of the Association; a subscription has been raised to defray local expenses; the offers of private hospitality have been numerous; special invitations have been given to the corresponding members, and a large number of distinguished foreigners; and every effort will be made to receive and heartily entertain visitors to the meeting. The Reception Room, at the Masonic Hall, Theatre Street, Norwich, will be open on Monday, August 17, at 12 o'clock, for the sale of tickets, and for supplying information to visitors. The local secretaries are—Donald Dalrymple, Esq., Rev. Hinds Howell, and the Rev. Joseph Crompton. Communications intended for presentation to the sections are expected to be forwarded before August 15th, addressed either to G. Griffith, Esq., Assistant General Secretary, 1, Woodside, Harrow, or to one of the local secretaries at Norwich, and to be accompanied by a statement whether the author will be present, and on what day, so that the business of the Association may be satisfactorily arranged. The *Opening Address* will be delivered in the Drill Hall, on Wednesday evening, the 19th of August, at eight o'clock, by Joseph Hooker, Esq., F.R.S., D.C.L., &c., President Elect. *Soirées* will be held in St. Andrew's Hall, on the evenings of Thursday, the 20th, and Tuesday, the 25th of August. *Evening Lectures* will be delivered in the Drill Hall, on Friday, the 21st, and Monday, the 24th of August, at half-past eight o'clock. Various *Excursions* (geological, archaeological, and ethnological) have been arranged to take place on Thursday, the 27th of August, to Cromer and its district, to Hunstanton, to Holkham, Castle Acre, Diss, Hoxne, Thetford, &c., full details of which, with times of trains, will be published in due course. Minor excursions, within a short distance of Norwich, are in course of arrangement, and will be notified at the time of meeting. A post-office will be opened at the Reception Room, Masonic Hall, Theatre Street, for the convenience of members, and to which members may have their letters directed. The Great Eastern, Great Northern, Great Western, North Western, and Midland Railway Companies will convey members, on the production of a pass ticket, at a fare and a half for the return journey. Trains between Norwich, Yarmouth, and Lowestoft will run frequently during each day.

Production of the Precious Metals.—Mr. J. Ross Browne, in his report to the Secretary of the United States Treasury on the mineral resources of the States and Territories west of the Rocky Mountains, says that a great increase in the production of both gold and silver is probable. In California, Australia, and Siberia gold mining is now conducted under many disadvantages. In the two former, wages and interest are exceptionally high, and in all there is a lack of that thorough knowledge and of those economical modes of working which can only be adopted by a generation educated to the business and devoted to it as a lifelong occupation. In Spain and Brazil, which were once

very rich in gold, and would probably pay for hydraulic washing, there must be numerous quartz veins that are now untouched. These will be made productive. The Andes and the Altai will be explored with care, and hundreds of veins as rich and large as those of Potosi and Guanajuato will be found. Machinery will be improved, so that tunnels or adits large enough for wagons can be bored five, ten, or twenty miles long, through high mountains, so as to pay for purposes of travel, and at the same time any lodes that may exist in the chain will be open to a depth far below anything known in mining. The great lodes of the future will not be discovered by such antecedents as those which revealed Potosi, Cerro Pasco, Sombrette, Chanarcillo, and the best mines of Catorce. If veins like those could be found by chance, what will not the well-directed explorations of the future find? It is scarcely to be doubted that a large tunnel, commenced 1,500 feet above the sea level, on the western slope of the Sierra Nevada, at any point between 36° and 40°, would in the course of ten miles run through a multitude of rich lodes. We have reason to believe that when the great mountains were formed numerous large fissures, running in some places for hundreds of miles, were filled with auriferous and argentiferous quartz; and we fail to find them not because they are not there, but because they are covered with earth, and because the clambering hunter, the benighted wanderer, or the charcoal burner, does not pull up the bush or does not light the fire in the right spot. A tunnel running through the Andes, commencing near Lima or Santiago, would reveal wonders; and the progress of mechanical industry is so marvellous that we are justified in hoping, if not in expecting, to see immense tunnels, fifteen or twenty miles long, cut through high mountain ranges.

CONTEMPORARY SCIENTIFIC PRESS.

[Under this heading it is intended to give the titles of all the chemical papers which are published in the principal scientific periodicals of the Continent. Articles which are merely reprints or abstracts of papers already noticed will be omitted. Abstracts of the more important papers here announced will appear in future numbers of the "CHEMICAL NEWS."]

Bulletin de la Société Chimique de Paris. December, 1867.

BOURGOIGNON: "An Improvement in Saponifying Fats."—MARTIN: "On the Preparation of Alizarine from the other Colouring Matters extracted from *Garrancine*."—J. PERROZ: "A new Aniline Black Dye."

Dingler's Polytechnisches Journal. January, 1868.

F. VARRENTRAFF: "On the Electro-deposition of Iron in a Solid Form."—FORTMANN: "On the Theory of the Process of Roasting Iron Pyrites."—R. REINMEYER: "On Dintrionaphthol, a new Colouring Matter extracted from Naphthalene."—P. ALFRAIER: "On J. A. Schlumberger's Method of obtaining a Green Dye from Toluidine."—J. VON LIEBIG: "On the Nutritive Properties of Unfermented Flour and Unfermented Bread." "On the Use of Chemical Products in the Manufacture of Bread."

Bulletin de la Société d'Encouragement. December, 1867.

E. PELIGOT: "On Sacé's Notes on the Colouring Matters in use at Neuchâtel for Dyeing Fabrics, and on the Use of Silicate of Soda for Dyeing."—DUMAS: "On the Use of Tartaric Acid for Dyeing."—E. PELIGOT: "On the Use of *Garrancine* for Dyeing."—TRILLIOT: "On a new Bitter Principle extracted from the Bark of the *Illex*, to be used as a Substitute for Quinine."

PATENTS.

Communicated by Mr. B. VAUGHAN, F.C.S., Patent Agent, 54, Chancery Lane, W. C.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

3625. B. Engel, Lawrence Lane, Chesham, London, "A new and improved composition for extracting ink and iron-mould from linen and woollen fabrics."—A communication from L. A. de L. d'Herlen, Boulogne-sur-Mer.—Petition recorded December 21, 1867.

176. E. Dorsett, London Street, London, "Improvements in the utilisation of coal tar and the products arising from the distillation thereof, and in the apparatus employed therein."—January 15, 1868.
524. J. A. Hogg, Montague Street, Edinburgh, "Improvements in the method of, and means for, increasing the combustion and illuminating power of gas."—February 15, 1868.
747. G. Davies, Salford Street, Lincoln's Inn, Middlesex, "Improvements in the manufacture of gas for lighting and heating."—A communication from L. C. E. Vial, Paris.
753. C. Schinz, Faubourg de Saverne, Strasbourg, France, "A process for the partial elimination of the nitrogen from the products of combustion and furnaces and apparatus connected therewith."—March 4, 1868.
785. J. Houston, jun., Glasgow, N. B., "Improvements in the manufacture of composite candles, and in the machinery or apparatus employed therein."—March 6, 1868.
821. C. D. Abel, Southampton Buildings, Chancery Lane, "Improvements in the production of brown colouring matters for dyeing and printing."—A communication from J. G. A. Gros, Mulhouse, Haut Rhin, France.
835. C. Attwood, Wolsingham, Durham, "Improvements in the production or manufacture of steel and iron of a steely character."—March 10, 1868.
835. F. Winsor, Manchester, and J. Swindells, Kegworth, Leicestershire, "Improvements in the utilisation of the waste products arising from Esparto grass and other fibrous materials used in the manufacture of paper and other purposes."—March 13, 1868.
836. F. Winsor, Manchester, and J. Swindells, Kegworth, Leicestershire, "Improvements in the manufacture of sulphate of magnesia."—March 21, 1868.
855. B. Britten, Red Hill, Surrey, "Improvements in the manufacture of manure."—March 12, 1868.
861. M. Kowand, Lewisham, Kent, "Improvements in the treatment or preparation of the ingredients employed in the manufacture of fermented liquors."—March 13, 1868.
884. H. F. Griffiths, and A. Deard, jun., "Improvements in apparatus for puddling iron and steel."—March 15, 1868.
897. W. E. Newton, Chancery Lane, "Improvements in the manufacture of illuminating gas in the distillation of hydrocarbons, and the making of gaseous fuel for heating purposes."—A communication from L. Stevens, Washington, Columbia, U.S.A.—March 16, 1868.
901. W. E. Gedge, Wellington Street, Strand, Middlesex, "Improved fuel, by the use of which the kindling of fires will be greatly facilitated."—A communication from K. N. Legendre, Passage des Petites Lencles, Paris.
909. W. E. Newton, Chancery Lane, "Improvements in producing steel and cast steel, and in furnaces or apparatus used therein."—A communication from A. Thoma, New York, U.S.A.
910. W. E. Newton, Chancery Lane, "Improvements in the process of preparing iron ore for smelting, and in furnaces therefor."—A communication from A. Thoma, New York, U.S.A.—March 17, 1868.
923. B. E. R. Newlands, F.C.S., Malvern Terrace, Charlton, Kent, "Improvements in treating and obtaining products from spent oxide of iron which has been used in gas works or otherwise, to separate sulphur from sulphuretted hydrogen, and in the purification of sulphur obtained from such oxide of iron."—March 18, 1868.
942. L. Kocussse, Madrid, Spain, "Improvements in the application of remedial agents to the human frame, and in the apparatus employed therein."—March 19, 1868.
946. J. W. Tatters, W. Keeble, and B. Newbery, Plymouth, Devonshire, "Improvements in the preparation of cigars, and mode of lighting the same."—March 20, 1868.

NOTES AND QUERIES.

It has been represented to us that our column of Notes and Queries has occasionally been made the vehicle for the surreptitious disposal of trade secrets by subordinates in chemical works, unknown to their principals. This column has proved to be sufficiently useful to a large class of our readers for us to be reluctant to discontinue it for the sake of a few who abuse its privileges. Probably a more rigid supervision will enable us to obviate the difficulty. There will be no objection to a correspondent asking for information on trade subjects; but the answer must likewise be made public, and in such cases no name or address can be given, no private communications forwarded through us, and no offer of payment for information can be published.

Nitrate of Iron.—Can any of your readers inform me how to make a good and cheap nitrate of iron? By inserting the above in the columns of your valuable paper you will much oblige—A CONSTANT READER.

Extract of Madder.—In answer to the query of your correspondent, "W. B." (*Am. Repr.*, June, 1868, p. 296), I beg to state that the extract of madder most in use now among the calico printers is that of M. Pernod, of Paris. Perhaps if he were to insert his query as an advertisement in a number or two of your Journal, he might be able to find some one who would be willing to communicate the process for a trifle.—H. S. DALE, B.A., Cornbrook Chemical Works, Manchester.

Aniline Green.—Cathartic Acid.—I make bold to trouble you with

these queries:—1st. Iodine green for dyeing: what is it, and how applied? 2nd. Cathartic acid. It has been stated that serena owes its purgative properties to cathartic acid; if there have been any confirmatory experiments on the subject, might I trouble you for the process for the extraction of this acid?—1st. Iodine Green.

Vessel for Holding Nitric Acid.—Could any of your correspondents tell me of anything in which 1,200 gallons or so of dilute nitric acid (1 of strong acid, by measure, to 20 of water), can be boiled, the heat being applied by steam inside?—R. C. M.

Nitrate of Iron.—Your correspondent, "Constant Reader" (*Am. Repr.*, July, 1868, p. 59), desires a cheap mode of preparing nitrate of iron; he does not state, however, whether he requires the proto-nitrate or the per-nitrate, the former and latter both are applied in dyeing and calico-printing. The proto-nitrate is best procured by so-called soluble decomposition, i.e., by treating a solution of sulphate of protoxide of iron with the nitrate either of oxyria, lime, or lead, the first-named salt being preferred on account of the great insolubility of that metal. The per-nitrate of iron may be prepared—1st, by pouring over clean iron filings gradually nitric acid of commerce, previously diluted with its own weight of water, to keep the whole well cooled down by placing the vessel wherein the solution is taking place into very cold water, since otherwise the peroxide of iron which results of the action is precipitated, instead of being dissolved and combined with nitric acid, the affinity between nitric acid and oxide of iron being very feeble indeed; another plan is to dissolve hydrated peroxide of iron in nitric acid; another yet is to decompose 1 eq. of persulphate of iron by 3 eq. of nitrate of lead or nitrate of baryta. This latter mode is sure to give excellent and instantly good results, but is rather more costly; if, however, nitrate of lead is used sulphate of lead is obtained as a by-product which is of some value, while the precipitated sulphate of baryta, in case nitrate of baryta were used, is applicable in various ways as permanent white, which daily finds a more and more extended sphere of useful application. For the preparation of persulphate of iron, which requires peculiar caution and manipulation, I must refer your reader to works on chemistry, or better, perhaps, on printing and calico-dyeing.—Dr. A. A.

Extraction of Grease by Bisulphide of Carbon.—If "C. L. W." will apply to "E. S." care of Messrs. Barry and Garnham, 129, W. Wellington Street, London Bridge, he may obtain all necessary information regarding this subject, also concerning the apparatus employed for the purpose.

Extraction of Grease by Bisulphide of Carbon.—If your correspondent, "C. L. W." will apply to Mr. Jesse Fisher, Ironbridge, Salop, I have no doubt he may obtain the information that he requires.

Extraction of Grease by Bisulphide of Carbon.—"C. L. W." will find whatever information he desires on this subject by inspecting, at the library of the Commissioners of Patents, Southampton Buildings, Chancery Lane, the numerous patents taken in reference to this subject, amounting to several dozens; it does not appear that, either in this country or abroad, there is any process in use which is not subject to Patent right.

Extraction of Grease by Bisulphide of Carbon.—Having had considerable experience in the employment of bisulphide of carbon as a solvent in manufacturing operations, I think I might be of use to your correspondent "C. L. W.", in respect to the apparatus which he requires.—H. B. COSBY.

Lithia.—I have access to an almost unlimited supply of lepidolite, and wish to know the best means of utilising it for the silica it contains. Will any of your courteous friends on the other side of the Atlantic, kindly inform me how best to set about this? I see from an announcement in our reprint of your invaluable journal that you will extend the same favours to American Correspondents that you have long granted to English ones.—A. K. Y., Tennessee, U. S. America.

Trinidad Pitch.—A correspondent wishes to know where he can purchase Trinidad pitch.—L. J. E.

Bleaching Woolen Rags.—George Watson, of Manchester, would be glad if any of your correspondents could inform him what is best for bleaching woolen rags previous to being torn up.

Colour of the Sea.—Cerebic Acid.—1. Where can I find the best account of Father Seebach's observations on the cause of the colour of the sea? Is there any authority (and if so, whose) for the statement made in "Marshall's Physiology," vol. II., p. 114, that cerebic acid is found in Indian corn, and to less extent in wheat? And if cerebic acid is really present, does it of necessity arise from protogon?—F.R.S.

Preparation of Subchloride of Copper.—The directions are:—Digest 4 parts finely divided metallic copper, and 5 of common black oxide of the metal in hydrochloric acid: prolonged digestion is necessary. Regarding the above I used the proportions given, and left them to digest in an open porcelain basin, using strong hydrochloric acid; after a week the whole of the metallic copper was not dissolved. 1. Should strong acid and a wide open basin be used of digestion? 2. Should it be digested with application of heat or not? 3. When the reaction is complete, should any of the metallic copper be left if used in proportions given? 4. Is this (Mallet's) method the cheapest and best for making oxygen in large quantities, or is the chloride of lime, or the other French processes, better and cheaper?—Enquirer.

Extract of Madder.—There are met with in the trade several preparations of madder, known as garancine, flowers, or bloom of madder, garanceux, azale, and colorin; the two latter are, in a sense, extractions. Azale is obtained by exhausting flowers of madder, fleur de garance,

with boiling wood spirit (not methylated spirit, but the methyl-alcohol of commerce); the mass is put on a filter, and to the filtrate water is added, whereby a copious yellow residue is thrown down, which is washed with water, dried, and afterwards applied for dyeing. Colorin, however, is obtained from madder by exhausting it with boiling alcohol, filtration, evaporation on a water bath, when an extract will be left which contains all that is soluble of madder in alcohol; it is better to use garrancine for this purpose, than madder, as it yields a better and far more pure product. If your correspondent "W. B." requires more details, he had better consult the numerous books on this subject published.—Dr. A. A.

Bleaching Woollen Rags.—These are most effectually bleached by the application of sulphurous acid. Of course, in many instances, the colour of the rags, supposing the same to belong to the class of dyed, or printed goods, will be also destroyed. Chlorine cannot be used for this purpose, for two reasons—first, because it causes woollen and silk fabrics to become yellow; and, secondly, it impairs the strength of the fibre, by entering into chemical combination with the wool, silk, and other similar substances of animal origin; as, for instance, sponge, animal gut, isinglass, &c., all of which, if requiring bleaching, are bleached by sulphurous acid.—Dr. A. A.

Lepidolite.—Your correspondent can utilise his lepidolite by extracting lithium, rubidium, cesium, and thallium from it. The following process will answer well on a large scale:—Fuse the mineral at a red heat, pour it into cold water, pulverise and wash it, treat the washed mass to twice its weight of hydrochloric acid. After several hours' boiling, separate the greater part of the silica, add nitric acid and protoxide of iron, and precipitate by carbonate of soda, the solution being made so weak that the carbonate of lithia will not be thrown down. After evaporation in this way in an iron vessel, to separate more carbonate of magnesia, saturate with hydrochloric acid and add the proper quantity of chloro-platinate of potassium to precipitate all the rubidium, cesium, and thallium. The filtered liquid, containing an excess of platinum and lithia, is treated with sulphuretted hydrogen to separate the platinum, then concentrated and treated with the carbonate of soda to precipitate the carbonate of lithia. By this method 1000 parts of lepidolite will give 78 parts of carbonate of lithia, 65 parts of chloride of rubidium and cesium, and 0.6 parts of thallium, supposing the operation to be continuous. The advantage of this process consists in the direct fusion of the mineral, and may be applied to all lithian masses.—A MANUFACTURER.

ANSWERS TO CORRESPONDENTS.

Science Teaching.—There is no better firm than the one you mention.

Enquirer.—The information is given in the present number.
Thos. Spencer.—Mr. Muter's letter on the permanganate water-test renders your communication unnecessary.

G. Benson.—Dissolve commercial aniline in dilute hydrochloric acid, evaporated nearly to dryness, and recrystallise two or three times from water.

G. Spencer.—We regret that it is out of our power to give the information required.

S. A. Sadler will receive a private communication in a few days.

Tyro.—Where the word salt is used by itself, common salt or chloride of sodium is intended to be expressed.

A. Smith.—A full account of the results obtained by the Editor in his investigations on thallium, down to January, 1864, together with a list of memoirs, is published in the "Journal of the Chemical Society," vol. xvii, p. 112.

E. Corbett, Junr.—We cannot say for certainty that they are patented, but it is extremely unlikely that such valuable processes should not be patented in this country.

Johnson's Patent Stoppers.—A correspondent wishes to know where these can be obtained.

W. O. Gervaux, Ohio, U.S.A.—Robbins's oxygensis is a mixture of biniodide of barium and bichromate of potash, both dry and in fine powder. On adding hot water or dilute acid to the mixture, oxygen is evolved.

C. L.—Mix modelling clay with glycerine instead of water. This will cause it to remain plastic.

J. Mayer.—The report is unavoidably postponed till next week.

Sodium.—Hyposulphite of soda is made at alkali works as a by-product in the manufacture of soda. You cannot make it economically from sulphate of soda.

A. B. C.—Olive oil is sometimes adulterated with poppy, sesame, earth-nut, or colza oil. The methods of detecting these adulterations are not very satisfactory; a good account of them is given in "Watts's Dictionary of Chemistry," under the heading "Oils."

J. Denham Smith.—A proof shall be forwarded. The letter arrived too late for insertion this week.

W. Berrie.—It is said that aniline colours may be discharged by a printing paste of powdered zinc and starch, and subsequent washing with acid.

W. B.—We can only insert your queries as an advertisement. It is not suitable for our Notes and Queries column.

A Manufacturer.—See answer to W. B.

A. A. Whitchelo.—In commercial examination of tobacco, the leaf should first be examined physically and microscopically, to detect adulteration. Then examine for ammonia and nicotine. Usually an estimation of the latter alkaloid present will suffice, in addition to that of the water, ash, and total nitrogen. Consult on this subject a very good article, by F. F. Mayer, of New York, reprinted in the CHEMICAL NEWS, vol. xli, pp. 73-88 (Eng. Ed.).

Mech.—Oil of Tartar is the name sometimes given to carbonate of potash which has deliquesced to an oily-looking liquid.

A Constant Reader, whose query on Nitrate of Iron was inserted a few numbers ago, is informed that a letter is awaiting him at our office.

Dr. T. R. Fraser, Halifax, Nova Scotia.—We regret that the article forwarded is unsuitable for our columns.

A Subscriber.—Charcoal from the ignition of white sugar would be the purest, but probably ivory black would answer your purpose best.

Chemicus Senior's letter has created much diversion. We shall probably print it. Will our correspondent favour us with his name and address, to add to it?

C. Hunter.—Careful addition of lime water, with free exposure to the air, would probably be found the best means of removing iron from the water.

P. C.—Bauxite is found at Baux, near Arles, in the south of France. It contains about 55 per cent of alumina, the rest being oxide of iron, water, &c. For price, &c., apply to M. Morin, Salindres, France.

Test Tube.—Two queries are inserted. The third was answered a short time back.

B. B. C.—Baillères, of Regent-street, have a collection of books on the subject. Consult these, and also the articles in Ure's and Watts's Dictionaries.

N. B. Bynard.—To give even a superficial outline of the subjects mentioned in your query would occupy several pages of the CHEMICAL NEWS. See the article in Watts's Dictionary.

B. W. Gibson.—Communication received with thanks. We will endeavour to make use of it.

Communications have been received from J. Sillett; W. F. Barrett; W. Bywater; H. Grubb; J. Samuelson; J. Horsley; A. Liveridge; W. Bartlett (with enclosure); Dr. B. H. Paul (with enclosure); J. B. Bird (with enclosure); P. Holland (with enclosure); G. F. Rodwell (with enclosure); H. B. Skyes; W. Kinder; O. Phillips; J. Solomon; G. Spencer; G. Benson; The Master and Wardens of the Society of Apothecaries (with enclosure); H. B. Condy; Thos. Spencer; Dr. Adrian; H. Gregory; G. Stephens; W. Ladd (with enclosure); E. J. Lloyd; J. A. Wykes; S. A. Sadler; J. Alexander; W. Walker; Dr. M. Reimann; W. Butler; Dr. G. E. Day, F.R.S.; A. Hensman; H. H. Watson; W. Thompson; J. C. Braithwaite; Murray & Heath; F. C. Calvert & Co.; A. McCulloch; G. W. Eccles; Muspratt, Brothers, & Huntley; Sydney Gibbons, Melbourne; D. Marples; E. Yendle; C. Horner; J. C. Brough; G. Fletcher & Co.; A. C. Bowdler; H. Baillière; G. Dickens; H. Streeter; J. Kemp; Dr. Odling, F.R.S.; Dr. Fraser, Nova Scotia; E. Corbett, Junr.; H. Thompson; W. O. Gervaux, Delaware, Ohio, U.S.A.; W. Hackney; Professor Maynard, Troy, N. Y., U.S.A.; M. A. Whitchelo; J. Spiller; W. F. Barrett; O. Scovola; W. White; Dr. E. Angus Smith, F.R.S.; H. Morton; W. Arndt; J. Heywood; J. Marples; Longmans and Co.; Churchill and Sons; J. A. Pooley; M. G. Maurice; W. A. Townsend and Adams; W. O. Reichardt; W. Chapman; G. F. Rodwell (with enclosure); M. Carmichael; C. Chateau (with enclosure); W. White; Dr. K. Angus Smith, F.R.S. (with enclosure); Walter Woodbury; J. Samuelson; Dr. B. H. Paul (with enclosure); E. A. Teschemacher and J. Denham Smith (with enclosure); F. W. Brearly; The Aeronautical Society of Great Britain; Dr. E. O. Rohrig; Rev. F. Sonley Johnstone; H. B. Condy (with enclosure); W. Briggs; W. Berrie; J. Mayer (with enclosure); Alfred Bird (with enclosure); Wm. Briggs; F. C. Calvert & Co., Manchester; Mawson & Swan, Newcastle-on-Tyne; W. A. Larder, Louth; Sampson Low & Co.; Dr. T. Wood (with enclosure); R. Campbell, Junr., Montreal; The Council of the Society of Arts (with enclosure); G. F. Rodwell (with enclosure); C. Greiville Williams, F.R.S. (with enclosure); J. Cliff; J. Smith, M.D., University of Sydney, N. S. Wales (with enclosure); Rev. B. W. Gibson, M.A. (with enclosure); Dr. Lyon Playfair, F.R.S. (with enclosure); Baron Von Liebig; C. J. Kaufmann; N. B. Rynard (U.S.A.); T. D. Reed, Canada; C. Hunter; H. J. Davies; W. Smallcome; A. Bird; J. W. Slater; H. McNaught; K. T. Dale, B.A.; E. Menzies; T. B. Fraser, M.D., Halifax, Nova Scotia (with enclosure); McDougall Bros. (with enclosure); Dr. Wood (with enclosure); H. Edwards; J. Parnell; Colonel W. H. Skyes, M.P.; E. F. Teschemacher; J. Denham Smith; J. Y. Buchanan; U. J. Kay Shuttleworth; Mawson and Swan; Albright and Wilson; J. Slessor; H. Jones; Townsend and Adams; J. Martin; Nicholson and Maule; Dunn & Co.

Books received.—"The Inductorium, or Induction Coll." by Dr. Noad, F.R.S. London: John Churchill & Sons; "Tea," by E. F. Bamber, London: Longmans & Co.; "Sanitary Siftings on Results of Sewage Systems Compared," by a Naval Officer. London: E. & F. N. Spon; "On Liquid Fuel," by Benjamin H. Paul, Ph.D. London: E. & F. N. Spon; "The Colonial Monthly, an Australian Magazine," December, 1867, and February, 1868; "On Dr. Muspratt's Discovery of a new Spa at Harrogate;" "The Chemical Manufacturers' Directories of England, Scotland, and Ireland." London: W. Kent & Co.; "A Dictionary of Chemistry," by Henry Watts, F.R.S. Part xlv, completion. London: Longmans & Co.; "The Journal of Materia Medica;" "A Key containing Answers to the Exercises in Galloway's First Step in Chemistry." London: John Churchill & Sons; "Annual Register of the Reinseler Polytechnic Institute, 1867-68."

We are indebted to correspondents for the following periodicals, containing reports and articles of chemical or scientific interest:—"The Chemist and Druggist;" "American Artisan;" "Mining and Scientific Press;" "Mining and Petroleum Standard and American Gas-Light Journal;" "Darlington and Stockton Times," May 16; "Le Moniteur Scientifique;" "Bulletin de la Société d'Encouragement;" "American Journal of Mining;" "The Acadian Reporter;" "The Darlington and Stockton Times;" "Mining and Scientific Press;" "American Artisan;" "American Journal of Mining;" "Journal of Gas Lighting."

THE CHEMICAL NEWS.

Vol. III. No. 2. American Reprint.

ON THE ESTIMATION OF CARBON IN CAST IRON, WROUGHT IRON, AND STEEL.

ANALYSIS OF A CHROMIFEROUS WROUGHT IRON.

BY M. BOUSSINGAULT.

M. BRECHE, an engineer, residing at Medellin, in Central America, sent me a specimen of cast iron derived from an oxidised iron mineral, reduced in a blast furnace fed with charcoal. It is white iron, in small plates, sp. gr. 7.45. Its hardness is great, and has been attributed to the presence of nickel. Upon dissolving the iron in hydrochloric acid a solution of a beautiful green colour is obtained. I soon saw that this colour was not due to nickel but to chromium.

Analysis gave:—

Combined carbon.....	4.40	per cent.
Graphite.....	—	
Silicium.....	0.75	"
Phosphorus.....	0.07	"
Sulphur.....	traces	
Arsenic.....	—	
Nitrogen.....	0.01	"
Manganese.....	0.84	"
Chromium.....	1.95	"
Vanadium.....	traces	
Iron.....	92.50	"
	100.52	

The estimation of the carbon having presented serious difficulties, I was induced to make a special study of this. I have been led to a process based upon the transformation of the iron into protochloride, without there being the least evolution of a gas capable of carrying off or burning the carbon. The agent which I use is bichloride of mercury. At first I worked in the dry way, and then with more success by the wet way.

The powdered iron is mixed with fifteen parts of bichloride. Add rapidly enough water to form a thin paste, which triturate for about half an hour in an agate mortar (when there is no objection to the introduction of a little silica, a glass mortar may be used). The diluted paste is introduced into a German flask, and kept for an hour at a temperature of 80° or 100°. Then throw it on a filter and wash with warm water. The protochloride of mercury, after being well dried in the oven, is put into a platinum boat and introduced into a glass tube communicating with a generator of dry hydrogen. Heat gradually up to a red heat in the current of gas. The protochloride is volatilised without decomposition; at least only very little mercury is reduced.

The volatilisation of the protochloride may equally well be effected in a current of nitrogen; but independent of the fact that it is not easy to keep up a sustained current of this gas, there will always be a suspicion of the presence of a little oxygen. In this respect hydrogen offers more security, especially if the device adopted at the *Ecole Normale au Conservatoire des Arts et Metiers* is employed, which consists in passing the dry hydrogen over a column of spongy platinum before it arrives at the tube containing the boat. The sponge retains the arsenic, and determines the disappearance of the oxygen which the hydrogen gas might contain.

In proportion as the protochloride of mercury disappears, the presence of carbon becomes manifest. Allow the boat to cool in a current of hydrogen, and then weigh it with the usual precautions. The carbon is voluminous, of a fine black; it lights and burns like tinder if the boat is heated a little. This is generally the case with carbon extracted from white irons, wrought iron, and steel. The graphite coming from grey cast irons only burns with the assistance of pure oxygen.

The carbon leaves an ash after its combustion. Before weighing this residue it must be heated red hot in a current of hydrogen.

From one gramme of white cast iron in large plates, I obtained—

Carbon..... 0.042 gramme.

After combustion there remained a crystalline residue having the appearance of silica. This residue, heated in a current of hydrogen gas, weighed 0.005 gramme, showing that the combined carbon weighed 0.037.

From one gramme of iron from a cementation furnace I obtained—

Carbon..... 0.009

After combustion—

Grey silicious residue..... 0.0015
 Carbon..... 0.0075

The carbon extracted from cast irons, steels, and even from the better qualities of iron, always leaves small quantities of ash. What is its origin? The silica of this ash when it comes from steel or wrought iron, in which it cannot be supposed to come from scoria, comes from silicide; but it does not represent the totality of this, because the silicium in combination with the iron, being first transformed into chloride by the bichloride of mercury, passes by the action of water into the state of silica, of which one part, being soluble, is carried away in the washings, while another part, insoluble, is left with the protochloride of mercury. It is this insoluble silica which is found after the combustion of the carbon. I have proved this by experiment.

The metallic substances submitted to the action of bichloride of mercury should be reduced to powder. There is no difficulty in this in the case of white cast irons, for they pulverise easily. But when grey cast irons, steel, and especially wrought irons, are operated on, recourse must be had to the file to divide them, and this is an inconvenience on which I do not need to insist. A skilful analyst, M. Damour, has tried whether it is not possible to chlorinise the iron without this preliminary division. He placed, in a spiral formed of platinum wire, a small steel cylinder weighing 1.06 grammes, and then suspended it in water containing 15 grammes of bichloride of mercury. It was put in a warm place. Two days afterwards the steel cylinder had disappeared: the protochloride of mercury, &c., was collected on a filter, washed, dried, and weighed. It yielded—

Carbon, &c..... 0.012
 Residue of silica..... 0.003

Carbon..... 0.009

If the silicium combined with the iron is attacked.

in the cold by the chlorine of the bichloride of mercury, this is not the case with crystallised silicium. Upon triturating this with bichloride and water, so as to form a thin paste, no reaction is remarked. For the silicium to be attacked the operation must be conducted at an elevated temperature. 0.5 gramme of crystallised silicium, mixed with bichloride of mercury, was placed in a platinum boat, introduced into a glass tube, and raised to a red heat. The vapour of bichloride of mercury was then passed into the tube: all the silicium had disappeared in the form of chloride of silicium, and only a trace of silica remained behind in the boat.

ON THE

ADULTERATIONS AND FALSIFICATIONS OF BREAD.

BY PROF. H. DUSSAUCE, CHEMIST.

BREAD kept for a few days experiences spontaneous alterations which render it unfit for use. Under the influence of heat, water, and acid yeasts, it often develops in that food cryptogamic vegetations of a dark green colour and a special odour, belonging to the family of mushrooms. Among these cryptogamies the most common species is that known by the name of *mucor mucedo*. When that vegetation is examined with the microscope, it is observed that the large tufts it forms are composed of simple pedicles, carrying at the top a globulous and membranous body, which is the receptacle. This organ is filled with grains by maturity, it is broken with elasticity in water, and the sporules which go out form a kind of beard. That plant presents different colourations, according to the degree of maturity of the sporules.

It has been observed that common rye bread, from one day to the next, was covered with a kind of red efflorescence, and emitted a very bad smell. MM. Payen and Mirbel ascertained with the microscope that this reddish substance was composed of round corpuscles, which were the sporules of a mushroom, the *oidium curatium*. These seeds, as those of the *mucor mucedo*, were developed on the loaves with a great rapidity, and would bear a temperature of 212° without losing their germinative property. This alteration can be prevented by diminishing the quantity of water in the bread, increasing the dose of salt, and using it twelve hours after being withdrawn from the oven.

The amylaceous matter of the bread is destroyed by these mushrooms, it is transformed into water and carbonic acid, while the mineral, nitrogenous, and fatty substances are assimilated, and feed the vegetal.

A bread which has a blackish-blue colour was prepared with flours from hard African wheat, and wheat of lower qualities from Smyrna and Salamque. Pogiale has ascertained that this bread does not contain inorganic substances, such as iron, copper, &c., and with the microscope he has found an innumerable quantity of infusoria of the genus *Bacterium* of Dryardin. These infusoria have not been observed in biscuits made with the same flour; the blue colouration of these infusoria was manifested only after the fermentation, the baking, and the cooling. The gluten of the flours which have produced this phenomenon was soft, coloured, disaggregated, and had a very bad odour.

The use of bread containing moulds ought to be rejected; indeed, several cases of poisoning have been ob-

served by the use of moulded bread. Johier has signalled the poisoning of three animals which had eaten moulded bread. Westerhoff has made known the case of poisoning of two children who had taken rye bread containing the *mucor mucedo*.

Bread prepared with flours altered by caries, darnels, &c., has a brown colour and bitter taste, and a disagreeable odour. Wheat damaged by weevil, sea-water, or any other cause, gives a brown, bitter bread, not very nutritive, and consequently improper for domestic use. When bread containing darnels, &c., is treated by alcohol, and the filtered liquid is evaporated, an extract is obtained which has an acrid and bitter taste. Sometimes rice, probably boiled, is added to the paste. Bread thus prepared contains from 7 to 8 per cent more water than ordinary bread. It is then important to exactly determine the proportion of water.

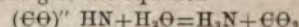
Experience has demonstrated in bread the presence of legumin, by diffusing in a very small quantity of a solution of potash, containing 12 per cent of alkali, a little crumb; by a microscopical observation the tissue proper to the legumin is seen, while all the grains of starch have disappeared.

When bread containing flour of horse-beans or vetch is successively treated by nitric acid and by ammoniacal emanations, lines coloured in rose are to be seen. That colouration often appears only after fifteen minutes.

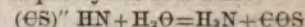
To ascertain potato starch in bread, examine by the microscope a little crumb, and add to it two or three drops of a solution of potash containing 1.75 per cent of alkali; the characteristic plates of the fecula are perceived if the bread has been adulterated with that starch.—*American Artisan*.

CARBONYLIC SULPHIDE.

THIS body, intermediate between CO_2 and CS_2 , has been long foreseen. THAN has recently succeeded in forming it and in determining its properties. He first attempted its direct synthesis by passing carbonous oxide CO , and sulphur vapour through a red-hot porcelain tube. A considerable quantity was thus produced, but it could not readily be separated from the excess of carbonous oxide. Moreover it was decomposed again by the heat into its constituents. Recalling then the fact that cyanic acid, by taking up the elements of water, was decomposed into carbonic dioxide and ammonia according to the equation



(in which cyanic acid is viewed as the imid of carbonic acid). Than saw that analogy required a similar decomposition for sulpho-cyanic acid thus:—

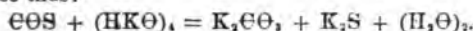


Experiment confirmed this theoretic view. By the action of strong sulphuric acid, the sulphocyanates take up H_2O and yield the gas with effervescence. The method of its preparation is as follows:—

Into a cooled mixture of five volumes concentrated sulphuric acid and four volumes of water, is placed in as much potassic sulphocyanate as will allow the mass to remain fluid. The evolution of gas commences spontaneously; should it become too violent the flask may be cooled by placing it in water; and if toward the close of the action it is too slow, a gas-flame may be put under it for a moment. Thus regulated, a constant stream of gas is obtained, which contains the vapour of water and of carbonic disulphide, as well as a

trace of cyanhydric acid, and probably of formic acid. It is allowed to pass through three U-tubes, the first of which contains cotton covered with moist mercuric oxide to absorb the acids, the second, pieces of unvulcanised caoutchouc to remove the CS_2 ,* and the third, calcic chloride to dry the gas. It is then collected over mercury, upon which when dry it has no action, even after many days. The moist gas, however, covers the mercury in a few hours with a thin coating of mercuric sulphide.

As thus prepared, carbonylic sulphide is a colourless gas, with an odour not dissimilar to that of EO_2 , but at the same time aromatic, recalling perhaps that of H_2S , though not at all disagreeable. It is soluble in its own volume of water, to which it communicates its odour. The taste of this solution is distinctly sweet, followed immediately by a peculiar prickly sulphur taste resembling that of H_2S and of SO_2 together. After a few hours, however, the solution exhales a strong odour of H_2S . It is twice as heavy as air, and may be poured from one vessel to another. It reddens litmus feebly, much more so than EO_2 . When ignited it burns with a beautiful blue, slightly luminous flame, yielding EO_2 and SO_2 . It takes fire very readily, even by a spark on a match. If the jar be held with the mouth downward, the gas burns completely; but if it be reversed, and a taper be introduced, the gas takes fire, while the taper is extinguished, and again relighted at the mouth of the jar. Under these conditions the combustion is incomplete, and sulphur is deposited. A cold and dry beaker-glass held over a jet of the burning gas, shows no trace of moisture. With $1\frac{1}{2}$ vols. of oxygen it forms an explosive mixture. Potassic hydrate absorbs the gas completely, though more slowly than EO_2 . Dilute acids evolve H_2S and EO_2 from this solution, so that the absorption appears to take place thus:



The potash solution gives a copious black precipitate with ammonio-argentic nitrate; no trace of cyanogen was found in the filtrate.

Neither chlorine nor fuming nitric acid has any action upon the gas at ordinary temperatures. Passed over heated mercury in a bulb-tube, no change is observed, though if long boiled in the gas a trace of mercuric sulphide is formed. When sodium is treated in the same way, a white crust is produced at the common temperature, which by heating easily melts and becomes darker. At a low red heat the sodium ignites, burning with a brilliant light and leaving a black, easily fusible mass, containing no trace of sodic cyanide, thus proving the absence of nitrogen in the gas.

When passed through mercuric-ethyl, at near its boiling point, a violent action takes place, pure metallic mercury without a trace of sulphide is separated, and a yellow liquid is produced, having a strong garlic odour. The author supposes it to be ethylic sulphopropionate.

If heated to low redness the gas is decomposed. This fact may be used to determine its composition as follows:—

Near the closed end of a U-tube, a fine platinum wire is fused, stretching across the tube. This arm being filled with the gas over mercury, and its volume ascertained, the wire is maintained at a bright red heat by means of the battery. About the wire the gas is

decomposed; thick heavy clouds of yellow sulphur-vapour fall down the tube till the decomposition is complete. After cooling, the residual gas possesses the original volume. It is odourless, does not render baryta-water turbid, and burns with a pale blue flame; the product of the combustion renders baryta-water at once milky. It is hence carbonous oxide.

Milligrams.

Since, therefore, 1 vol. (22.33 c.c.) carbonylic sulphide weighs 60
and 1 vol. (22.33 c.c.) carbonous oxide weighs 28

The weight of the sulphur in the gas is 32

The gas contains therefore one atom of E , one of O , and one of S , and its formula is EOS .

Two determinations of its density were made by Bunsen's method. The first, however, was on a portion of the gas before the use of the tube containing caoutchouc; it retains therefore a trace of CS_2 vapour. The observed density is 2.1152 and 2.1046 in the two experiments; the calculated is 2.0833. 60 is therefore its molecular weight. These results were confirmed by direct analyses of the gas, made according to Bunsen's methods.

In the opinion of the author, this gas is widely distributed in nature. Because it is so easily decomposed by water into EO_2 and H_2S , however, it has generally been confounded with these substances. From some experiments of his own, Than thinks he can assert almost positively that this compound is contained in the new and remarkable thermal spring of Harkány; and also in the cold sulphur spring of Pará, both in Hungary. He sustains this view by the fact that the water freshly drawn has precisely the odour of the gas, which recalls, but cannot at all be mistaken for that of H_2S ; though on standing a few hours, the sulphydric acid odour appears. For these reasons it is probable that it occurs in many other sulphur springs, and it can scarcely be doubted that it could be found among the sulphur gases of volcanic action, and perhaps in those arising from organic decomposition.

It is recognised by the following reactions: 1st. Potassic hydrate deprives the gas, or its watery solution, at once, of its peculiar odour. The alkaline solution effervesces with dilute sulphuric acid, evolving H_2S (distinction from EO_2). 2nd. In acid solutions of silver or cadmium it produces no precipitate; but upon the addition of ammonia, the respective sulphides appear (distinction from H_2S). 3rd. Sodic nitroferri-cyanide has no action in neutral or acid solutions; but an intense blue-violet colour is developed by potash or ammonia. 4th. Iodide of starch is decolourised in a short time by this gas.—*Ann. Ch. Pharm., Suppl.*, Band v., 236, Oct., 1867.

ON THE PROPOSED WATER SUPPLY FOR THE METROPOLIS.*

BY EDWARD FRANKLAND, PH.D., F.R.S.,

PROFESSOR OF CHEMISTRY, ROYAL INSTITUTION.

(Concluded from American Reprint, July, 1868, page 27.)

HAVING thus discussed the organic portion of the solid impurity of these waters, let us now turn to the inorganic or mineral portion, which may be conveniently divided, as regards its most important constituents, into three subdivisions, viz. :—

* The success of this device is so great that Than recommends its use in all similar cases. The CS_2 is completely removed.

* Read before the Royal Institution of Great Britain, Friday, April 3, 1868.

1. Soap-destroying substances.
2. Mineral compounds, constituting chiefly the skeleton of decomposed sewage or manure.
3. Poisonous substances, such as arsenic, copper, and lead.

The first or soap-destroying category of substances communicate to water the quality called hardness. These substances are the salts of lime and magnesia; and the quantity of them contained in the proposed, as compared with the present, metropolitan water supply will be seen on reference to the analytical table. The hardening effect of these substances is also given in a separate line of the same table, from which it will be seen that the proposed is only about 1-10th as hard as the present water supply.

Tastes differ as regards hard or soft water for drinking purposes, and medical arguments have from time to time been advanced, now in favour of and now against each. It has been asserted in this country, for instance, that hard water is necessary for the formation of bone, and that the finger of Providence points to the advantage of hard water by the profusion of calcareous strata occurring in the earth's crust, whilst M. Belgrand states that the inhabitants of the hard-water districts of France notoriously suffer from carious teeth. It would probably be extremely difficult to prove either of these assertions. As regards the enormous advantages of soft water for washing, cleansing, and manufacturing purposes, there is, however, no difference of opinion. In Glasgow alone the annual saving of soap only, by the introduction of Loch Katrine water, for a previous supply of very moderately hard water, has been estimated at 36,000*l*. Having had the opportunity of comparing a six years' experience of the soft water supplied to Manchester, with a subsequent ten years' experience of the hard water of London, I can state that the soft water was for all purposes preferred by every member of my family. On removing from Manchester to London, the repugnance to drink the hard water of the latter city was at least as marked as that which I have sometimes noticed in persons making the transition in the opposite direction.

The hardness of the London waters is chiefly what is termed *temporary hardness*; that is, it is caused by the carbonates of lime and magnesia, the greater portion of which is gradually deposited on boiling the water for half-an-hour. By reason of this softening of such water by boiling, temporarily hard water is considered to be less objectionable than water of the same degree of permanent hardness. My own experience leads me to the conclusion that the advantages of temporary over permanent hardness have been considerably over-rated. In reality, water used for domestic purposes is, even when used hot, either not heated to the boiling point, or is boiled for too short a time to remove more than a small proportion of its temporary hardness. Thus, water drawn from the kitchen boilers of a dwelling-house and of the Athenæum Club was usually almost as hard as the cold water with which they were supplied, as is seen from the following table:—

Date and Hour.	Hardness of Cold Water.	Hardness of Hot Water.
Sept. 30th, 1867, 8 P.M.	14.6	13.6
Oct. 1st " 8 P.M.	14.4	13.9
" 2nd " 8 A.M.	14.4	13.4
" 3rd " 9 P.M.	14.6	11.6
" 4th " 8 A.M.	14.6	7.6
" 7th " 8 P.M.	14.4	11.7

Date and Hour.	Hardness of Cold Water.	Hardness of Hot Water.
Oct. 8th, 1867, 8 A.M.	14.4	12.1
" 9th " 8 P.M.	15.4	14.3
" 10th " 8 P.M.	15.9	11.9
" 11th " 8 A.M.	15.9	8.4
" 12th " 8 A.M.	16.1	11.9
Nov. 8th " 5 P.M.	18.7	18.4
" 11th " 5 P.M.	18.7	18.6
" 12th " 6 P.M.	18.7	18.4

The amount of soap destroyed by the use of various waters for washing purposes is seen from the following table, in which certain Welsh and Cumberland waters are also introduced for the purpose of comparison:—

Soap destroyed by 100,000 lbs. of various Waters.

	lbs. of Soap destroyed.
METROPOLITAN WATERS.	
Thames Water	212
River Lea	204
Kent Company's Water	265
OTHER WATERS.	
South Essex Company's Water	253
Caterham Company's Water	84
Water supply of Worthing	285
" " Leicester	161
" " Manchester	32
" " Preston	80
" " Glasgow (Loch Katrine)	4
" " Lancaster	1
Bala Lake	5
Thirlmere	8
Haweswater	16
Ullswater	23

In the recent supply of water to Paris from new sources, the importance of soft water attracted the attention of the eminent engineer M. Belgrand; a close investigation of the available sources, however, soon showed that he had unfortunately but little choice, as the really soft streams of the Fontainebleau sands (the minimum hardness is however 6°) and of the granite of Morvan (minimum hardness 2.2°) were mere dribbets. Of the latter M. Belgrand says:—"Sources qui donnent les eaux les plus pures du bassin du la Seine; déviation vers Paris impossible, en raison du peu d'importance des sources." Hence the river Vanne (17°-20°), somewhat softer than the Thames, was the softest available source, and having first conclusively demonstrated this, he consoles the Parisians by saying—"Les eaux du granite, du greensand et des sables de Fontainebleau, qui sont chimiquement plus pures, sont beaucoup moins agréables à boire."

The second category of inorganic substances contained amongst the solid impurities of waters, consists of the mineral compounds constituting chiefly the skeleton of decomposed sewage or manure. The putrescible nitrogenous organic matters present in water, or in the soil through which water percolates, undergo gradual oxidation and decomposition, by which their carbon and hydrogen are converted into carbonic acid and water, and their nitrogen into ammonia, nitrous and nitric acids. The last three remain in the water, constituting a record of previous contamination with putrescible nitrogenous organic matter. But rain-water always contains ammonia, and, as Dr. Bence Jones has shown, also nitrous and nitric acids. The nitrogen in these forms in rain-water, as it finds its way into rivers and springs, amounts in the aggregate to .032 part in 100,000 parts of water, therefore this amount must be deducted from that found on analysis, as nitrogen derived

from aerial sources. The remainder, if any, represents the nitrogen derived from putrefied nitrogenous organic matters with which the water has been in contact. To express this in terms of some known standard, I employ average filtered London sewage, which contains 10 parts of nitrogen in the form of putrescible organic matter in 100,000 parts. Thus, a water which contained one part of nitrogen in 100,000, as nitrous acid, nitric acid and ammonia, would contain 100,000 parts, the nitrogenous remains or skeleton of an amount of putrescible organic matter equal to that contained in 10,000 parts of average filtered London sewage. Such a water therefore is said to have a previous sewage contamination of 10,000 parts in every 100,000 parts. But it may be asked, Is this a true record of the previous history of the water in this respect? I believe it to be so, as far as it goes. *I believe that this nitrogen as truly represents a quantity of previously existing putrescible organic nitrogenous matter, as that the bones of a megatherium demonstrate the previous existence of an individual of that species; but as the geological record of previously existing organisms is imperfect, so is the nitrogenous record; just as chemical and mechanical agencies have broken up and dissipated the remains of millions of animals during long geological periods, so does the action of growing plants, and perhaps also of living animals, remove from water, in a few hours or days, some portion of this skeleton of previous putrescible organic matter. Thus by storage in large reservoirs, the East London Company reduced the previous sewage contamination of the river Lea last summer from about 2,000 down to 230 parts in 100,000. The previous sewage contamination of a water as determined by analysis is therefore a minimum quantity.*

But in addition to the aerial, for which due allowance is made, can there not be some other source of this skeleton than putrefied sewage or manure matter? Can it not be derived from putrefied vegetable matter—from peaty matter for instance? Without utterly denying the possibility of this, I venture to assert that nowhere, in this country at least, nor probably on the continent of Europe, is there such a quantity of nitrates, nitrites, or ammonia produced from vegetable sources as to appreciably affect the truth of my proposition that the nitrogen in these forms obtained by waters from terrestrial sources is substantially due to the putrefaction and oxidation of sewage and manure matters.

It has been objected to this view of the origin and significance of these forms of combined nitrogen, that waters derived from comparatively deep wells, in the chalk for instance, contain them in large quantities; thus the Kent Company's water exhibits a previous sewage or manure contamination of from 3,000 to 5,000 parts in 100,000. It is difficult to understand how such an objection could have originated, and it certainly disappears on examination; for instance, in the above case, it is well known that a very large proportion of the water collected in the London chalk basin consists of the drainage from manured land, and it is doubtless from this source that the large proportion of nitrates existing in this water is derived.

According to Mr. Way's analysis, the drainage water from cultivated land contains an amount of nitrates corresponding to the following proportions of previous sewage contamination in 100,000 parts:—

	Max.	Min.	Mean.
Previous sewage contamination of drainage- water from manured land.....	54,490	7,040	20,370
Do from pasture-land, unmanured.....	2,100	180	830

The results of the examination of various well-waters contained in the following table, further illustrate this point:—

Previous Sewage or Manure Contamination in 100,000 parts of various Well-waters.

Names of Waters.	Nitrogen Previous as Nitrates Sewage and Contamina- tion.	
	Ammonia.	Nitrites.
Artesian Well at Grenelle.....	—	006
Chalk Well at Caterham.....	009	000
Water delivered by Kent Company.....	001	408
Water supplied to Worthing.....	000	426
Water delivered by the South Essex Company.....	006	848
Shallow Well at Leyland, near Preston	003	2466
“ at Ledbury.....	001	1575
“ at Redhill.....	002	1446
“ in Aldgate.....	—	3840
“ in Minories.....	—	5738
“ in Leadhall Market.....	—	5769
“ in St. Nicholas Olave Churchyard.....	—	7596
Well in the Rue Traversine, Paris.....	—	30029
Royal Institution Well-water.....	001	4355

With two remarkable exceptions the above results show the greatest previous sewage contamination precisely in those places where it would be predicted; thus the shallow well-water of Leyland, near Preston, consists almost entirely of the drainage from cesspools and market gardens, through a sandy soil, the latter being heavily manured with night-soil, stable manure, and guano. It need therefore excite no surprise that nearly 25 per cent of this water has been in a condition equivalent to average London sewage. The quality of the waters taken from four of the city pumps and from the well in the Royal Institution* needs no comment; these shallow wells are now recognised as being fed by oxidised and somewhat diluted sewage. It is, however, in the well of the Rue Traversine, in Paris, that this kind of contamination reaches perhaps its maximum. The cesspool system is still in full activity in Paris, and the soil of that city is saturated with liquid manure of such a strength that one gallon of it is equivalent to three gallons of average London sewage.

As already mentioned, there are in the above table two remarkable exceptions to the general previous sewage contamination of well-waters. These are the artesian well at Grenelle and the chalk well of the Caterham Water Company. With regard to the first, it is evident that the pressure of water which supports a column of 122 feet above the surface at Grenelle, precludes the possibility of admixture with the drainage of

* As this water enjoyed for a long time a very high reputation in the domestic department of this Institution, and as I have been frequently and very earnestly requested to withdraw a prohibition which I placed upon its use in the cholera year, 1866, I append, for my own justification, a more complete analysis.

	In 100,000 parts.
Total solid impurity.....	937
Organic carbon.....	440
Organic nitrogen.....	085
Nitrogen as nitrates and nitrites.....	4355
Ammonia.....	001
Total combined nitrogen.....	4441
Previous sewage contamination.....	43240
Actual contamination with unoxidised sewage	4250
Hardness.....	325

The gases dissolved in this water contained scarcely a trace of oxygen. A half-pint glass of it contains nearly a quarter of a pint of water which has previously been in the condition of average London sewage, besides a dessert-spoonful of actual or unoxidised sewage. It seems, therefore, highly probable that filtered and tolerably well-oxidised sewage in its undiluted condition, would furnish the most popular water supply for London. Such is the reliability of instinct in these matters.

Paris; still there can be little doubt that the water supplying the chalk of the Paris basin is, to some extent at least, contaminated by manure, although the land through which it drains is far less generally cultivated than that through which the water supply of the London chalk percolates. The water from the Caterham Company's well, comes, I believe, from a greater depth than that of the Kent and South Essex Companies', and this circumstance, coupled with the observation of Mr. Dugald Campbell that the water of the deep chalk wells, unlike that of the shallower chalk wells, is free from nitrates, and taken in connection with the fact that there is free water-communication between the upper and lower chalk, points to the conclusion that chalk possesses the property of abstracting nitrates from water. If this be the case, it would also account for the circumstance that the water of the shallow chalk-wells exhibits much less previous sewage contamination than might be expected; the average amount of nitrates found by Mr. Way in drainage water would indicate a previous sewage contamination in the chalk-water, equal to about 20,000 parts in 100,000, whilst the contamination actually exhibited in the case of the Kent, Worthing, and South Essex Companies' waters is only: Kent, 3,770, Worthing, 3,940, and South Essex 8,205 in 100,000 parts.

I have extended this investigation to various river and lake waters, as well as to spring waters, and have been here much indebted, as regards the non-British waters, to M. Boussingault's researches on the presence of nitrates in waters. The following tables exhibit the results of this investigation:—

Previous Sewage, or Manure Contamination, in 100,000 parts, of various River and Lake Waters.

Names of water.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Previous Contamination.
RIVER WATERS.			
Nile.....	—	102	700
Rhine, at Bâle.....	—	026	0
Seine, at Notre Dame.....	—	152	1200
Oureq.....	—	223	1910
Thames.....	005	234	2062
Lea.....	002	220	1901
Severn (near source).....	003	007	0
Lower Clywedog.....	004	006	0
Tarannon.....	008	024	0
Ceryst.....	001	052	210
Carno.....	003	049	190
Banw and Eira.....	004	023	0
Vyrnwy.....	003	011	0
Tylwch.....	003	004	0
Upper Rothay.....	003	002	0
Lowther.....	002	003	0
Kent.....	001	045	140
Sprint.....	000	021	0
Fourteen other Cumber-land Streams.....	—	—	0
LAKE WATERS.			
Bala Lake.....	001	000	0
Thirlmere.....	003	002	0
Haweswater.....	004	000	0
Ullswater.....	003	005	0
Watendlath Tarn.....	002	006	0
Loch Katrine.....	002	031	0
Five Lakes and Tarns examined by Boussingault.....	—	—	0

Previous Sewage, or Manure Contamination, in 100,000 parts, of various Spring-waters.

Name of Waters.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Previous Contamination.
Mother Ludlaw's Cave.....	001	034	30
Water supplied to Ferette (Haut Rhin).....	—	039	70
Spring near Durmenach (Haut Rhin).....	—	114	820
Source of the Roppensviller Haut Rhin).....	—	168	1360
Source of the Arcueil.....	—	1111	10700
" " But at Montmartre.....	—	8563	85310
" " Martinet.....	—	557	5250
" " Trois Meules, St. Etienne.....	—	210	1780
Spring at Nîmes.....	—	129	970
Ebersbronn (Bas Rhin).....	—	447	4150
Water Supplied to Woerth-sur-Saier (Bas Rhin).....	—	259	2270
Source of the Li, near Winckel (Haut Rhin).....	—	104	720
Liebfrauenberg Spring (Bas Rhin).....	—	005	0
Seltz (Bas Rhin).....	—	008	0
Mineral Spring of Bussang (Vosges).....	—	003	0
Water supplied to Thann (Haut Rhin).....	—	010	0
Source of the Boelacker (Haut Rhin).....	—	018	0
Spring at Castle Fleckenstein (Bas Rhin).....	—	Traces	0
Thermal Spring at Baden.....	—	016	0
" " Dax.....	—	013	0
Source of the Presle (East Pyrenees).....	—	013	0

The results embodied in the above tables throw considerable additional light upon this form of water contamination. They show in the first place that waters which have not been in suspicious company exhibit little if any previous sewage contamination, thus in the whole of the Cumberland and Westmoreland district it only occurs in one instance (the Upper Kent which, as every tourist knows, has a little cultivated land on its banks), and that to a small extent only. In the Welsh waters again there are only three instances. The spring-water, which issues from the Greensand beneath an uncultivated but heather-covered surface at Mother Ludlaw's Cave, near Farnham, exhibits a mere trace of this contamination, whilst the waters of nine springs on the Rhine, in the Vosges, and in the Pyrenees, examined by M. Boussingault, exhibit no indications of previous sewage contamination. On the other hand, the spring forming the source of the But and issuing not far from the cemetery at Montmartre at once discloses its antecedents, and exhibits a previous sewage contamination of 85,310 parts in 100,000. It will be seen that the water of the Oureq, which is now used only for watering the streets of Paris, exhibits a previous sewage contamination somewhat less than Thames water.

But what is the import of this previous sewage contamination? These skeleton compounds are innocuous, why trouble ourselves about them? True, they are innocuous, or nearly so; but, inasmuch as they show that the water has been in contact with animal refuse, they bring a heavy charge of suspicion against it. These refuse animal matters are known to contain that which is hurtful to human life. This hurtful matter is believed, on very strong evidence, to consist of spores, or germs of organisms, which are capable, under favourable circumstances, of producing in man such diseases as cholera, typhoid fever, and dysentery. Now such spores or germs, endowed as they are with vitality, will be likely to resist the oxidising agencies which convert the rest of the animal refuse into carbonic acid, water, nitric acid, nitrous acid, and ammonia. For instance, if the contents of an egg were beaten up with water and poured into the Thames at Oxford, the organic matter would probably be entirely

oxidised and converted into mineral compounds before it reached Teddington; but if the egg were thrown whole into the Thames at Oxford, it would, if it retained its vitality, be carried down to Teddington without any decomposition of its organic matter. There can be no doubt that the spores or germs of many organisms are in like manner capable of resisting for a long time the decomposing action of water. Now no practicable process is known by which these spores, once introduced into water, can be again removed or can have their vitality destroyed. Filtration will not do it; in fact it is well known to engineers that water is often contaminated with visible suspended matter which cannot be separated by filtration; thus M. Belgrand says, "Lorsque l'eau est troublée dans le fleuve, elle sort louche de nos filtres." And again, speaking specially of the London water supply, "Le mode de dégrossissage employé par les grandes compagnies anglaises, très convenable à Londres, ou l'on ne boit pas d'eau, ne vaut rien à Paris, où les femmes, les enfants, les vieillards de la classe ouvrière n'ont pas d'autre boisson. J'ai constaté par moi même, et les ingénieurs anglais n'en disconviennent pas, que l'eau sort des filtres très chargée de matière organique." Again, in the account of his highly remarkable researches on vaccine and small-pox poisons, recently communicated to the Academy of Sciences, M. Chauveau says, regarding the organic germs contained in these poisons, that they "ne se déposent jamais complètement dans les couches profondes du milieu ambiant, et passent à travers tous les filtres."

Boiling even for several hours cannot be relied upon for the destruction of such germs, some of which have recently been shown to retain their vitality after four hours' boiling; in fact there can now no longer be any doubt that as contended by M. Pasteur, the cases of so-called spontaneous generation have all had their origin in ignorance of the excessive tenacity of life in the germs of the lowest organisms.

Nothing short of distillation therefore, as it is carried on in nature, can be relied upon to free, completely, sewage-contaminated water from its noxious constituents. Excessive filtration is doubtless to some extent a safeguard, and hence previous sewage contamination in chalk-water, if we could be certain that the water had been fairly filtered through some 100 feet of chalk, and that none of it gained access to the wells through fissures or swallow-holes, would have far less significance than it has in the case of a river-water where the fine-suspended and noxious matters of sewage have but a comparatively slender chance of removal before the water reaches the consumer. We must also not forget that mere dilution fails, in the case of these suspended germs, to destroy their noxious quality, differing as they do in this respect remarkably from soluble poisons. The daily casting of a thousand fatal doses of strychnine into the Thames at Oxford ought not to occasion so much alarm amongst the London water-drinkers as the present flow of the Oxford sewage into the river, because the excessive dilution of the soluble strychnine would effectually prevent its producing any physiological effect. Each noxious living germ, on the other hand, contains within itself the power of indefinite multiplication and mischief. One such germ may be present in a wine-glassful of water, whereas it would be necessary to drink many thousand gallons of water to imbibe a noxious amount of strychnine, under the conditions just alluded to. I am therefore of opinion that water once contaminated with sewage or

manure matter ought never again to be used for domestic purposes, if any other supply can be obtained; and I endorse the advice of M. Belgrand and the principle which guided him in the selection of the new water supply for Paris:—"On a dit des eaux potables, qu'elles étaient comme la femme de César, qu'elles ne devaient pas même être soupçonnées, et c'est mon avis."

A few words will now suffice regarding the third class of mineral matters that may be present in the solid impurities of waters, viz., *poisonous substances, such as arsenic, copper, and lead*. These substances are only likely to occur in waters connected with mineral workings—one of them only, lead, has been detected in the proposed supplies, and that only in two streams in Cumberland, and in quantity far too minute to require any further notice.

The following table exhibits a comparative view of the amount and quality of the gases contained in the proposed and present supplies:

Gases expelled on boiling 100 volumes of various Waters.

Names of Gases.	Welsh Waters. Mean.	Cumberland Waters. Mean.	Thames Water. Mean.	Distilled Water.
Nitrogen.....	1'323 ..	1'424 ..	1'656 ..	1'133
Oxygen.....	'612 ..	'726 ..	0'801 ..	'617
Carbonic acid.....	'227 ..	'281 ..	3'652 ..	'105
	2.162	2.431	6.109	1.855

You will find that the gases contained in the Welsh and Cumberland waters are very similar in quantity and proportion to those found in recently distilled water. Collected as these waters are near the mountain ranges which constitute the great condensers of natural distillation, this is exactly the result we should expect. The London waters differ mainly in containing more carbonic acid in solution, which makes them more sparkling in appearance. Sparkling waters are generally preferred by the public, although they commonly owe their briskness to extensive contact with decaying organic matter. It is thus that the highly-sparkling pump-waters of London are still preferred by many. On the other hand, soft waters are not necessarily rapid; no draught of water could be more delicious than that which is obtained from the public drinking-fountains of Glasgow, supplied from Loch Katrine, although I find that 100 volumes of this water contain only the following gaseous constituents:—

Nitrogen.....	1.731 vols.
Oxygen	'704 "
Carbonic Acid.....	'113 "
	2.548

Action upon Lead.

The conditions which determine the action or non-action of water upon lead, have hitherto been involved in much obscurity. Messrs. Graham, Miller, and Hofmann, the Government Commission of 1851, on the supply of water to the metropolis, established the fact that the presence of dissolved oxygen and the absence of more than three volumes of carbonic acid in 100 volumes of water, are amongst the conditions necessary for the attack of lead.

The whole of the present water supply of the metropolis is perfectly protected from acting upon lead by the large quantity of carbonic acid which it contains. Still there are obviously other conditions involved in the problem; for all the samples of water from the Welsh and Cumberland districts contain, as

shown in the above analytical results, dissolved oxygen, whilst not one of them possesses an amount of carbonic acid even remotely approaching that which is necessary to protect it, and yet some of these waters act violently upon lead, whilst others are entirely without action upon the metal. Having recently had occasion to observe that a sample of distilled water, which acted powerfully upon lead, completely lost this quality by momentary contact with animal charcoal, I found on further investigation, that a minute quantity of the chief constituent of bone-black, viz., phosphate of lime, completely protects water from action upon lead. I then carefully examined for phosphate of lime, the water of the River Kent (Upper Kent), which is eminently distinguished for its violent action upon lead, and the water of the river Vyrnwy, which although nearly as soft as distilled water, has not the slightest action upon lead, even when placed in contact with a bright and freshly-cut surface of the metal for 24 hours. This examination established the fact that the water of the Vyrnwy contained an appreciable amount of phosphate of lime, whilst not the slightest trace of this substance could be detected in that of the Upper Kent. The waters from both the proposed districts have been carefully examined as regards their behaviour towards lead, and, as the result of this examination, it may be safely affirmed that no danger on this score need be apprehended from the introduction of water from either districts into the metropolis. I here exhibit to you samples of lead in various waters exemplifying the points upon which I have just spoken.

Lastly, I place before you in these large cylinders, holding more than a gallon each, samples of the Welsh and Cumberland waters, side by side with a similar sample of Thames water, which fairly represents the condition of more than 3-5ths of this water as it has been delivered in London since 21st of January last. But it may be asked, will these waters from Wales or Cumberland reach the metropolis in this colourless, transparent, and soft condition after passing through a conduit from 180 to 280 miles in length? Let me tell you what I conceive will be the effect of such a conduit upon the water. For the first two or three years a certain amount of lime from the surface of the cement in the conduit will dissolve in the water, communicating at first an amount of hardness probably not exceeding 5°; this effect will gradually subside, and after two or three years the water will be delivered in London in a slightly better condition than that in which it leaves the storage reservoirs—a slightly better condition because it will be somewhat better aerated than when it starts on its journey. At the present moment the water of Loch Katrine passes through a conduit 26 miles long, and I have lately carefully taken its hardness as it leaves the lake and as it is delivered to consumers in Glasgow. Its hardness on delivery in Glasgow is only 0.3°, exactly the same as in the lake, and its transit through 26 miles of conduit has therefore added no hardening constituent to the water. Now, if 26 miles of conduit fail to alter the hardness, I can only conclude that 180 or even 280 miles of conduit, if properly constructed, will also, after the lapse of a few years, be equally incompetent to produce any substantial increase in the hardness. At the time the above experiments were made, Loch Katrine water had flowed through the conduit for seven years.

These are the principal points I have to bring before you in connection with the proposed supply, and as a

summary of the chemical investigation of the present water supply, on the one hand, and of the samples furnished by the Welsh and Cumberland districts on the other, I may state the following conclusions to which these investigations have led me:—

1. The present water supply of the metropolis is largely contaminated with sewage. Both analysis and statistics concur in the statement that each glass of Thames water taken from the river by the companies, contains one teaspoonful of sewage.

2. Although this sewage is generally to a great extent oxidised before the delivery of the water in London, yet there is no guarantee whatsoever that all its noxious qualities are removed, because these noxious qualities are, in all probability, contained in the mechanically suspended and least oxidisable portion of the sewage.

3. The river water supplied in London is often very imperfectly filtered; and thus even the visible suspended matters of sewage are not wholly excluded from the water supply. Only on one occasion during the whole year 1867, have I obtained a transparent sample of water from the Southwark Company's mains. The Grand Junction Company's water was turbid four times out of twelve, the Chelsea thrice, the West Middlesex, Lambeth, and East London each twice, out of the twelve occasions when the samples were drawn for analysis. The New River Company alone delivered perfectly filtered water during the whole year.

4. The quality of the water supplied to London is greatly inferior to that of any other town in the United Kingdom, whose supply I have examined.

5. The distribution of water in the metropolis still continues, with but slight exceptions, on the intermittent system, a system which has been abolished in almost every town of importance in the United Kingdom.

6. The water which it is proposed to supply either from the Welsh or the Cumberland districts is of excellent quality. It is equal or superior to that supplied to any town in Great Britain.

7. The water from each of the proposed districts is extremely soft, pleasant to drink, and of good aëration.

8. These waters have never been contaminated with sewage, and are therefore above all suspicion.

9. They can be distributed in the present system of supply pipes without any danger of lead contamination.

The choice between the present and proposed supply rests virtually with the intelligent inhabitants of the metropolis. Will you go to a source of pure water uncontaminated with sewage, or will you continue the existing supply? I can anticipate your verdict, but you must not delay to record it. These splendid sources now available will not remain much longer within your reach.

In conclusion, I beg to quote the opinion of one of our highest medical authorities on the dangers of sewage-contaminated water. Unpleasant as the theme may be, this opinion is in the highest degree deserving the earnest attention of every individual who has progressed beyond the state of savagery. In his report on the Cholera Visitation of 1866, Mr. Simon, the medical officer of the Privy Council, says:—"It cannot be too distinctly understood that the person who contracts cholera in this country is *ipso facto* demonstrated with almost absolute certainty to have been exposed to excremental pollution; that what gave him cholera was (mediately or imme-

diately) cholera-contagium discharged from another's bowels; that, in short, the diffusion of cholera among us depends entirely upon the numberless filthy facilities which are let exist, and especially in our larger towns, for the fouling of earth and air and water, and thus secondarily for the infection of man, with whatever contagium may be contained in the miscellaneous out-flowings of the population. Excrement-sodden earth, excrement-reeking air, excrement-tainted water, these are for us the causes of cholera. That they respectively act only in so far as the excrement is cholera-excrement, and that cholera-excrement again only acts in so far as it contains certain microscopical fungi, may be the truest of all true propositions; but whatever be their abstract truth, their separate application is impossible. Nowhere out of Laputa could there be serious thought of differentiating excremental performances into groups of diarrhoeal and healthy, or of using the highest powers of the microscope to identify the cylindro-tenium for extermination. It is excrement, indiscriminately, which must be kept from fouling us with its decay.

"And thus it is that my practical advice remains substantially what it has been for years. The local conditions of safety are, above all, these two:—(1) that, by appropriate structural works, all the excremental produce of the population shall be so promptly and so thoroughly removed, that the inhabited place, in its air and soil, shall be absolutely without faecal impurities; and (2) that the water supply of the population shall be derived from such sources, and conveyed in such channels, that its contamination by excrement is impossible.

"What good results are got even by rough approximation to those sanitary standards has already been abundantly shown here. The way in which the southern districts of London, with their three-fourths of a million of population, have gradually gained comparative immunity from cholera in proportion as their two water companies have ceased to distribute sewage-tainted water among them, is a matter of familiar history.

"That cholera is still a terror to Europe shows how scantily such illustrations are yet understood. Even here in England the objects which I have named as essential are at best but rarely fulfilled; indeed for vast numbers of our population scarcely rudimentary endeavours have been made to attain them. Town after town might be named, with myriad on myriad of population, where there is little more structural arrangement for the removal of refuse than if the inhabitants were but tented there for a night. The case of the water supply is no better: my reports are incessantly showing the too frequent foulness of private supplies, while as regards public water supplies, such as generally are in the hands of commercial companies, it has again and again been shown (and seldom more pointedly than in the present volume) that their conveniences and advantages are counterbalanced by dangers to life on a scale of gigantic magnitude, unless those who administer the supplies act under a very deep sense of responsibility.

"Cholera, ravaging here at long intervals, is not Nature's only retribution for our neglect in such matters as are in question. Typhoid fever and much endemic diarrhoea are, as I have often reported, incessant witnesses to the same deleterious influence; typhoid fever which annually kills some 15,000 to 20,000 of our population, and diarrhoea which kills many thousands besides. The mere quantity of this wasted life is something horrible to contemplate, and the mode in which the waste is caused is surely nothing less than shameful. It is to be hoped that, as the education of the country advances,

this sort of thing will come to an end; that so much preventable death will not always be accepted as a fate; that for a population to be thus poisoned by its own excrement, will some day be deemed ignominious and intolerable."

ON THE ARTIFICIAL FORMATION OF ORGANIC SUBSTANCES.*

BY C. GREVILLE WILLIAMS, F.R.S.

CHEMICAL researches are liable at various epochs to take special directions. Before 1830, organic chemistry was comparatively little studied. The simplification of the methods of organic analysis by Liebig, took place at a most opportune moment, and gave an extraordinary impetus to the study of carbon compounds. So great was this influence that proximate and ultimate analysis made a progress the rapidity of which was unexampled in the history of science.

But chemists soon became dissatisfied with merely determining the composition of substances, and they very soon began eagerly to study their products of decomposition, and in this manner get a clue to the way in which nature had put them together.

The successful attack on this problem led to a much grander one suggesting itself. This was to utilise the insight analysis had given them into the constitution of substances, and to endeavour to build them up without the assistance of life. The lecturer showed that we thus arrive at the two great engines of chemical research, *analysis* and *synthesis*.

He then proceeded to define and illustrate experimentally these terms.

In inorganic chemistry the information supplied by the analysis of a substance often renders its synthesis easy. Water was decomposed by a battery, and the properties and quantitative relations shown. The mixed gases were then introduced into a soap-bubble, so prepared as to last a considerable time. It was by a simple contrivance attached to a thread, and the lightness of the enclosed gases was shown by the fact that the bubble was able to raise the thread and a disc of paper into the air. The energy with which the mixed gases combine to form water, was then shown by applying a light to the bubble, when it burst with a loud report. This simple but delicate experiment was twice repeated successfully. The quantitative synthesis of water was experimentally shown by passing hydrogen over cupric oxide in an apparatus which allowed of the collection of the water. It was then shown that in organic chemistry the molecules are generally too complex to be put together so easily; and this statement was proved by reference to the constitution of methylamine, the simplest of the organic alkaloids.

The lecturer then went somewhat fully into the question of the propriety of the use of the terms "organic" and "inorganic." He showed also that all the attempts hitherto made at separating chemistry into two distinct branches had failed; Liebig's definition of organic chemistry as the "chemistry of compound radicles" being obviously inadequate, inasmuch as some compound radicles (such as sulphuryl and phosphoryl), are certainly inorganic.

Laurent's definition, "chemistry of carbon," is equally insufficient, inasmuch as carbonic anhydride, and carbonic tetrachloride, are as clearly inorganic as sulphuric anhydride or sodic chloride. He then pro-

* A lecture delivered before the Royal Institution of Great Britain, Friday, May 8th, 1868.

ceeded to argue that chemistry was "one and indivisible," and stated that one of the chief aims of his discourse was to prove that assertion.

It was shown that until within the last few years all the specific attempts made to break the apparently natural barriers between organic and inorganic chemistry had proved failures.

It was true that in the course of the innumerable researches and experiments made by chemists, one or two of the simple organic bodies had presented themselves; but, like urea and cyanogen, they were substances which, as it were, hovered on the confines of inorganic chemistry, and would have been called inorganic had they not contained carbon.

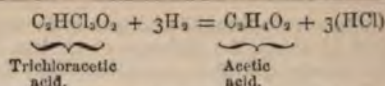
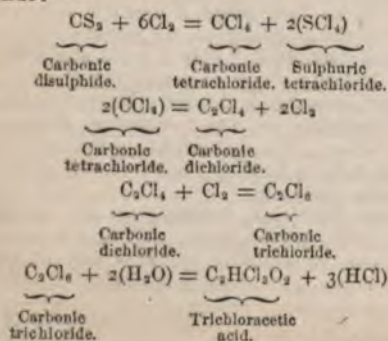
The grand problem, which consisted in taking the elements themselves, and building them up *gradatim* into the proximate principles existing in the tissues of plants and animals, until lately appeared almost hopeless. This apparent difficulty was shown to arise from the mistake of supposing the proximate principles of animals and vegetables to result from an occult power vaguely termed the "vital force." It was at one time supposed that the laws which regulate combination, were either suspended or modified in the tissues of living creatures, but it was argued that, whenever the proper reagents were made to act upon each other under the proper conditions, the same substances were produced which at one time were supposed to require the aid of vitality for their formation.

The problem of the "synthesis," or building up of the so-called organic substances, was then shown to present itself (in the present state of chemistry) under two aspects:—1st. Where they are prepared by the aid of reagents, which have themselves been produced directly or indirectly from animals or vegetables. 2d. Where the synthesis was effected from the free elements themselves, from hydrogen and pure carbon.

The lecturer then proceeded to enumerate some of the principal instances where substances originally derived from animals or vegetables had been formed synthetically. Wohler's synthesis of urea was shown to be one of the earliest in point of date, and his method was described and also Kolbe's new process by the mere heating of ammoniac carbonate to a point just below that at which urea is decomposed.

One of the next most important steps in the history of synthesis was shown to be the conversion of carbonic disulphide into carbonic tetrachloride or perchlorinated marsh gas. Inasmuch as carbonic disulphide is a purely inorganic body, it is evident that the formation of any substance from it is a case of true synthesis.

The following equations represent the steps by which acetic acid may be produced from carbonic disulphide:—



This important series of reactions, then, result in the production of acetic acid, one of the most marked of the so-called organic acids, from purely inorganic materials.

The synthesis of oxalic acid by the direct union of carbonic anhydride with sodium, as recently accomplished by Dr. Drechsel, was next described, and it was shown that as oxalic acid, by mere distillation, yields formic acid, the synthesis of the first acid led directly to a new synthesis of the second.

The other modes of effecting the synthesis of formic acid were then pointed out, viz.:—Berthelot's process, which consists in heating potassic hydrate in an atmosphere of carbonic oxide; and Kolbe and Schmidt's method, by exposing potassium to a warm moist atmosphere of carbonic anhydride.

The lecturer, in the course of his remarks on the constitution of formic acid, showed that the quantity of oxygen in it was so large that it only required one atom more to convert it into carbonic acid and water. Its easy oxidation was illustrated by letting it fall on plumbic dioxide in an apparatus which caused the evolved gas to pass into a solution of baric hydrate, the result being a copious precipitation of baric carbonate.

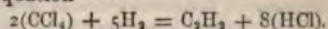
Having shown that acetic acid can be formed from carbonic disulphide and the chlorides of carbon, and oxalic and formic acids from the oxides of carbon, the lecturer proceeded to indicate the modes in which complex bodies, hitherto obtained from animal and vegetable sources, can be built up from elemental carbon and hydrogen.

If carbon can only be made to combine directly with hydrogen, no matter how simple the resulting compound may be, it becomes possible to effect the synthesis of a vast number of the most characteristic substances found in animals and vegetables.

This brilliant result has been accomplished through the agency of acetylene, a most remarkable hydrocarbon which was first noticed by Edmund Davy as long ago as 1836.

There are two methods by which acetylene can be formed from inorganic materials—one devised by Berthelot, and the other by the lecturer. The first consists in passing a stream of hydrogen through a globe in which the voltaic arc (from 70 or 80 cells of a Grove's battery) is produced between carbon points. At this tremendous temperature, the carbon unites directly with the hydrogen. The experiment was made, and the production of acetylene shown, by the formation of a precipitate in a solution of ammoniacal cuprous chloride.

The speaker then showed, experimentally, that much larger quantities of acetylene can be formed by the decomposition by the induction spark of carbonic tetrachloride in presence of hydrogen, in accordance with the equation—

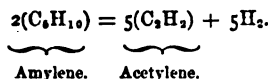


The experiment succeeded perfectly, and a large quantity of the cuprous acetylide was rapidly produced.

But the most simple and ready means of preparing acetylene was shown to be by drawing air through the flame of a common glass spirit lamp, by means of an aspirator. So readily is the cuprous precipitate obtained by this means, that it suffices to draw a few

cubic centimetres through the solution of ammoniacal cuprous chloride to obtain evidence of the presence of acetylene in the flame. In a few seconds the solution became quite thick with the suspended precipitate.

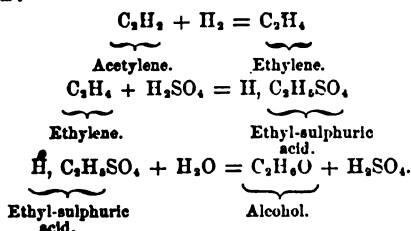
All the homologues of olefiant gas give acetylene in abundance when subjected to the induction spark. Amylene does it readily in accordance with the annexed equation:—



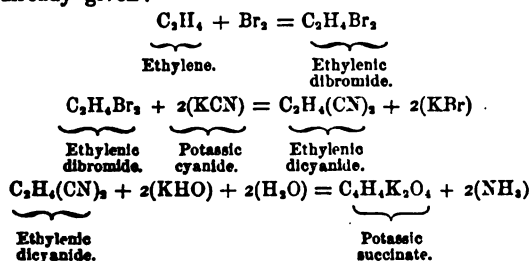
That the spark acted only in consequence of its high temperature, the speaker said, is rendered probable by the fact that if hydrogen be passed through carbonic tetrachloride, and then into a globe containing a platinum spiral, when the latter was heated to dull redness by three cells of a Grove's battery, no acetylene was produced; but when five cells were used, and the spiral became white hot, the cuprous precipitate was obtained readily. The same result was stated to occur with amylenes.

Simple as the formula of acetylene is, almost all the animal and vegetable substances which have been formed by pure synthesis may be obtained from it.

The following equations represent the steps by which alcohol may be "synthesised." It is proper to premise that the conversion of acetylene into olefiant gas is accomplished by treating the cuprous acetylide with zinc and ammonia, so as to obtain nascent hydrogen:—



The synthesis of succinic acid from acetylene was next shown in accordance with the annexed equations, omitting the synthesis of ethylene, which has been already given:—



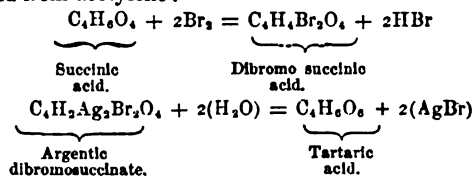
This mode of effecting the synthesis of succinic acid is due to the researches of Maxwell Simpson.

The beautiful appearance of succinic acid under the influence of polarised light was shown by the aid of the electric lamp. The specimen used having been artificially prepared.

The speaker then proceeded to show that the synthesis of succinic acid was a direct step to that of tartaric acid. This latter reaction is due to the researches of Perkin and Duppa.

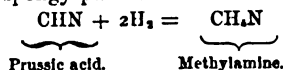
The artificial formation of succinic acid, starting with acetylene, having been proved, it is only necessary to

start with that acid to prove the synthesis of tartaric acid from acetylene:—



The lecturer next proceeded to show how the synthesis of the organic alkaloids could be effected from inorganic materials.

In the first place the fact that cyanides can be produced by heating carbon in presence of nitrogen and an alkali, is well known. The next step is to procure prussic acid by distilling cyanides with acids. From pure prussic acid, methylamine, the simplest of the primary monamines, can easily be obtained, either by the aid of nascent hydrogen, or free hydrogen in the presence of spongy platinum.

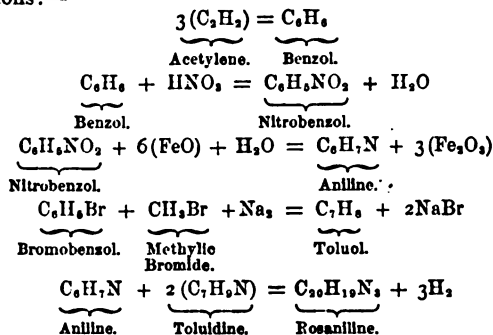


This equation has been realised by both the methods given above, the first by Mendius, the second by Debus.

It is also evident that as alcohol can be obtained from acetylene, so all the ethylic, primary, secondary, and tertiary monamines of Hofmann can now be synthetically formed. The steps being (1), conversion of acetylene into olefiant gas. (2). Passage of olefiant gas into alcohol. (3). Alcohol into iodide of ethyl. (4). Action of iodide of ethyl on ammonia.

Again, acetic acid, it has been shown, can be prepared from carbonic disulphide. Now acetic acid, by the action of a red heat, can be made to yield a number of the homologues of olefiant gas. The latter, by treatment with excessively strong hydriodic acid, become converted into the iodides of the alcohol radicals (Berthelot). By following up this last reaction with pentylene, heptylene, octylene, and nonylene, the lecturer succeeded in obtaining pentylamine, heptylamine, octylamine, and nonylamine.

The direct ascent from acetylene to the coal tar colours was then shown according to the following equations:—



These transformations were all described at length. In effect acetylene passed through a red hot tube becomes polymerised into benzol.

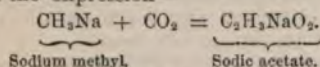
The passage of toluol into nitro-toluol and toluidine is omitted in the above equations, because the reactions are identical in kind with those of benzol into aniline.

In describing benzol, experiments were shown illus-

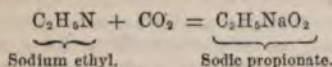
trating the density of its vapour as compared with air. In one of these, benzol was poured into a large beaker containing a hot iron; at first the benzol assumed the spheroidal form, but, as the temperature fell, it became converted into vapour, which filled the beaker. A glass syphon was then introduced into the beaker, and the vapour drawn off as if it had been a liquid, and inflamed. The vapour descending through the syphon was then received into a warm beaker, from which it was decanted into another beaker in which it was inflamed.

The speaker then proceeded to show the way in which the synthesis of zinc ethyl could be effected; it is, however, unnecessary to follow the equations in detail, because, having already explained the manner in which alcohol can be synthesised from acetylene, it is obvious that zinc ethyl can be directly derived from that fluid.

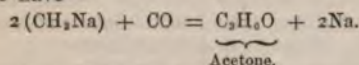
Wanklyn's interesting synthesis of acetic acid from sodium methyl was then shown to take place in accordance with the expression—



The method appears to be general, inasmuch as the same chemist has effected the synthesis of propionic acid:—



And, substituting carbonic oxide for carbonic anhydride, we have—



The speaker stated that one of the most interesting of the cases of synthesis recently accomplished was that in which Mr. W. H. Perkin had succeeded in producing artificially the odoriferous principle of new hay and the tonquin bean.

The delicious fragrance of new hay is entirely due to the presence of the sweet-scented vernal grass, *anthoxanthum odoratum*. It is the same substance which is the cause of the sweet smell of the woodruff, *asperula odorata*; the melilot, *melilotus officinalis*. It is also the flavouring ingredient in the *mai wein* of the Germans, which is perfumed with woodruff.

Until lately, nothing was known about coumarin, except that it was a colourless crystalline body, having the formula—



The crystals of coumarin appear very beautiful under the influence of polarised light. The image of some artificial coumarin, which had been fused and allowed to crystallise in a plate of glass, was then thrown upon the screen, and the light being polarised by the aid of Nicol's prisms, the crystals assumed the most gorgeous and varying colours as the prisms were rotated.

The clue to its constitution was shown to be the circumstance that when heated with potassic hydrate it yields salicylic and acetic acids. The production of salicylic acid from coumarin was then shown, experimentally, the presence of the acid being proved by its yielding a deep purple colouration with ferric chloride.

Artificial coumarin was obtained from the hydride of salicyl. By treatment with sodium it yielded hydride of sodium salicyl; this substance, heated with acetic anhydride, gave hydride of aceto-salicyl. This last substance was then distilled with acetic anhydride and sodic

acetate, and when the temperature reached 290°, the distillate solidified to a mass of crystals of pure coumarin, having all the fragrance and beauty of that obtained from the tonquin bean.

The speaker submitted that the assertion he had made at an early period of his lecture that there was no natural barrier between organic and inorganic chemistry, had been amply proved by the instances he had brought forward. He said that they had studied together that evening several cases where, starting from inorganic matter, they had ascended step by step until they had reached some of the most complicated bodies secreted by animals and vegetables. What, he said, could be more distinctly inorganic than nitrogen, carbon, and oxygen? What more distinctly an animal secretion than urea? What more completely inorganic than acetylene? What more distinctly vegetable in origin than coumarin?

Chemists have then, so far, done what a very few years ago would have been regarded as possible only by the aid of the vital force. A true organic substance, he said, is so definite that we can almost invariably determine its molecular weight, and it is generally crystalline. But when we come to the tissues we are dealing no longer with organic substances, but with organised beings, and we feel that we are approaching the barriers which separate the study of life from the study of matter. The bonds which unite them are so close that we cannot imagine life *without* matter, and it is equally difficult to conceive the assumption of vitality *by* matter; but we must never cease to look anxiously for the solution of the problem. The impossible is a horizon which recedes as we advance, and the *terra incognita* of to-day will to-morrow be boldly mapped upon every schoolboy's chart!

CHEMICAL CONSTITUTION AND ITS RELATION TO PHYSIOLOGICAL ACTION.*

BY DR. A. CRUM BROWN, F.R.C.P., EDIN., &c.

CHEMICAL composition is an expression which has a perfectly definite meaning. By it we understand the proportions of the elements (or hitherto undecomposed substances) which can be obtained from a substance, or from which it can be built up.

In investigating the composition of a substance it is a matter of secondary importance *how* it has been decomposed or *how* it may be reconstructed; what we wish to know is, what are its ultimate constituents, and how much of each it contains. The knowledge of the intermediate steps is only valuable so far as it is necessary to prove that we have lost nothing and added nothing. It is quite different when we come to consider *chemical constitution*. Here we have to deal not only with the nature and quantity of the constituent elements, but with their relations to each other in the compound. The difference between composition and constitution may be illustrated by very many analogies. I shall make use of a familiar one. The *composition* of a household is expressed by the number of persons contained in it, with the sex and age of each, but its *constitution* is not known, until we have the relations in which they stand to one another, as husband and wife, parents and children, master and servant, &c.

If we assume the existence of atoms, we may define constitution as the relation of the atoms to one another

* Read before the Pharmaceutical Meeting, Edinburgh.

in the compound, just as the constitution of a family is the relation of the individuals composing it to one another. We have now to inquire, how these relations may be discovered, and how they may be expressed. We discover them by examining the way in which the compound is built up or decomposed, and we express them by means of "rational" or "constitutional" formulae. In the case of the family alluded to above, we should know the constitution if we knew the history, that is, if we knew by what steps these particular individuals came to live together in one house; and in the same way, the history of a compound, or the steps by which it was produced from its elements, leads us to a knowledge of its constitution. As, however, the work of destruction is generally easier than that of construction, we are often obliged to take the course of gradually, so to speak, picking the compound to pieces, and learning its history backwards.

It would be out of place for me here, even did time permit, to give detailed examples, showing how the constitution of particular substances may be determined; a very clear account of the subject will be found in the article, "Formulae, Rational," by Professor G. C. Foster, in Watts's "Dictionary of Chemistry." It is sufficient here to indicate some of the general results. We believe, then, that the atoms in a compound are related to one another in such a way that atom is united to atom, and that when two groups of atoms are united together, it is by individual atoms of the one uniting with individual atoms of the other. We find that the atoms of some elements can each enter into only one relation, those of some into two, those of some into three, &c.; such atoms are called monatomic, dyatomic, triatomic, &c., respectively; if we prefer English to Greek names, we may call them singly-related, doubly-related, and so on. We find, further, that an atom which in one compound is singly-related, becomes in another trebly- or fivefold-related, and that a doubly-related atom may, in the same way, become fourfold- or sixfold-related; the change in the number of relations (what is called the change of "atomicity") taking place, in the vast majority of cases, by two at a time, so that an atom which has an odd number of relations in one compound has an odd number in all, and may, therefore, be called *oddly-related* ("perissatomic"), and an atom which has an even number in one, has an even number in all, and may be called *evenly-related* ("artiatomic").

These relations have been expressed in a great variety of ways; most completely by the system of "graphic formulae," first introduced by Professor Kekulé in 1859. These graphic formulae have received many modifications; in one of these, which I proposed in 1861, each atom is represented by a circle containing the symbol of the atom, and the relations by lines proceeding outwards from the circumference and connecting the circles with others. Such graphic or pictorial representations have not unfrequently been objected to as expressing more than we know, and as leading readers to imagine that they show the relative position of the atoms, of which, of course, we are entirely ignorant. I think I shall be able to show you that this accusation is unfounded, and, at the same time, illustrate the meaning of chemical constitution, by applying the same graphic method to a case where the idea of position in space does not enter at all. Let us suppose that John is occupant of a house which belongs to Mr. Smith, and is situated in Edinburgh, and that Thomas occupies a house belonging to Mr. Brown in Glasgow; then represent-

ing John by J, his house by E, Smith by S, Thomas by T, his house by G, and Brown by B, we may

express their relations thus; $\begin{array}{c} S \\ | \\ E-J \end{array}$ and $\begin{array}{c} B \\ | \\ G-T \end{array}$ without

meaning that the landlord is situated above and the tenant at the side of the house. Now if it is convenient for John to go to Glasgow and Thomas to Edinburgh, they may change houses, and we have,

$\begin{array}{c} S \\ | \\ E-J \end{array}$ and $\begin{array}{c} B \\ | \\ G-T \end{array}$ becoming $\begin{array}{c} S \\ | \\ E-T \end{array}$ and $\begin{array}{c} B \\ | \\ G-J \end{array}$.

Here we have two groups, one in Edinburgh and one in Glasgow, before the change and after it. The only difference is, that we have John and Thomas each in the position previously occupied by the other. These two men may be totally unlike in every other respect, but they are capable of replacing each other in this particular relation. So in chemistry; when chloride of sodium and nitrate of silver are brought together, the silver and the sodium change places, each taking up the relations previously held by the other. This is an example of what is called double decomposition.

Now let us suppose a slightly more complicated case. Let John be proprietor as well as occupant of his house.

Here we have $\begin{array}{c} B \\ | \\ E=J \end{array}$ and $\begin{array}{c} B \\ | \\ G-T \end{array}$ In this case John is

doubly-related and united by both bonds to the house. If he now change with Thomas, the state of matters will

be represented thus: $\begin{array}{c} B \\ | \\ G-J \end{array}$ Before the change $\begin{array}{c} B \\ | \\ E-T \end{array}$ two

groups, but only one after. The corresponding chemical reaction is termed addition, and groups to which addition can be made in this way are said to be *condensed*. The condensation obviously consists in the atoms being united together by more bonds than are necessary to ensure the unity of the group. Thus J and E are united by two bonds, while one would be sufficient. We have an instance of this kind of addition in the union of chlorine and olefiant gas. The two carbon atoms of olefiant gas are doubly related to one another; by the action of chlorine one of these relations is broken and each carbon atom becomes related to a chlorine atom.

Addition may take place in another way, namely, by an increase in the number of relations of an atom; thus in ammonia, nitrogen is trebly-related, being united to three atoms of hydrogen, but when ammonia is brought into contact with hydrochloric acid, chloride of ammonium is formed, the nitrogen becoming fivefold-related, being united to four atoms of hydrogen and one of chlorine. We may illustrate this by supposing that John, who is already doubly-related, borrows £1000 from Robinson, and buys another house, thus entering into two new relations, one to his creditor and one to his investment. Now if we offer Robinson a better investment, he will call up his money from John, who must either borrow from some one else or sell one of his houses. Both cases occur in chemistry; if we mix caustic potash with chloride of ammonium, we offer, so to speak, the better investment of potassium to the chlorine, which accordingly leaves the nitrogen, but the nitrogen, at the same time, loses one atom of hydrogen, just as John parted with his creditor and one of his houses together; but if we try a similar

experiment with the chloride of a complex ammonium (such as chloride of tetramethylammonium), mixing it, say, with moist oxide of silver, and thus tempting the chlorine to leave the nitrogen and unite with silver, the nitrogen does not lose a methyl atom long with the chlorine, but, if I may use the expression, pays off the chlorine by borrowing from oxygen. This analogy might be carried much further, but it is unnecessary to do so. My object is attained if I have shown that *any* kind of relation which can be single, double, treble, &c., may be used to illustrate chemical constitution, and that we are not necessarily restricted to geometrical relations.

Our time does not allow me to dwell longer on this part of the subject; I shall, therefore, proceed to the consideration of the relation between chemical constitution and physiological action.

The difficulty of determining this relation depends mainly on our ignorance of the constitution and action of the great majority of substances, which makes it impossible for us to make much progress by direct comparison of constitution with action. All that has been made out in this way is, that the soluble compounds of what we may call a poisonous element, such as lead, have all nearly the same action, and similarly of a poisonous radical, such as cyanogen. Here, however, we meet some remarkable exceptions; thus, kakodylic acid, although readily soluble, and containing a large amount of arsenic, is inert, and a number of the double cyanides, such as ferrocyanide of potassium, show no trace of the action of hydrocyanic acid.

In this difficulty it occurred to Dr. Fraser and myself, that another method of inquiry might lead to better results. The method which we have adopted consists first, in introducing a known change into the constitution of an active substance; and, second, in comparing the action of the new product so formed with that of the original substance.

The first set of substances to which we applied this method (in an investigation communicated to the Royal Society of Edinburgh, January 6, 1868) was the group of vegetable alkaloids, and we have treated in this way strychnia, brucia, thebaia, morphia, codeia, and nicotia. Each of these alkaloids contains a trebly-related atom of nitrogen, which can easily be made fivefold-related. We do not know what its original three relations are, but we know what the two new ones are which we introduce. Thus, confining our attention to strychnia (and what is said of it applies with slight modification to the others), we find that a molecule of that alkaloid contains two atoms of nitrogen; of the connections of one of these we know nothing, of the other we know that it is trebly-related, and that we can make it enter into two new relations. We can do this by uniting it to an acid, hydrochloric acid for instance, in which case the new relations are, one to hydrogen and one to chlorine; to use the old metaphor, it borrows from chlorine and invests in hydrogen. We cannot, however, compare the action of strychnia with that of its hydrochlorate, for a very slight inducement is all that is necessary to make chlorine call up its investment, and retire with an atom of hydrogen. To try the effect of addition we must add two new relations of a more stable kind. This is done by acting on strychnia, not with an acid, that is a compound of hydrogen, but with an ether or compound of methyl or ethyl, such as iodide of methyl or iodide of ethyl. Here the nitrogen borrows from iodine and invests in methyl or ethyl, and the resulting compound is so stable that it has

no tendency to recur to its former state. These peculiar compounds were first studied chemically by How, and afterwards by Stahlschmidt. The latter made some experiments with methyl-strychnium salts on rabbits, and came to the conclusion that they were quite inert. A more complete examination has shown that this is not exactly true, but that a still more remarkable change has been produced. Large doses (thirty grains) of the iodide of methyl-strychnium (the compound of strychnia with iodine and methyl) produce no effect whatever when administered to a rabbit by the stomach; fifteen grains, however, kill a rabbit when injected under the skin. In this case the symptoms are quite unlike those of strychnia poisoning; instead of violent tetanic convulsions, we observe a condition of general paralysis. Now it is important that we should know *how* this paralysis is produced, and for this purpose we had recourse to a method which has been very successfully applied to the study of various poisons, especially "urali" or "curare," the South American arrow poison. To make this method of experimenting intelligible, I shall compare the nervous system to a set of telegraph wires and offices. Let us suppose that every town in the country has two telegraph offices, and that each is connected by a wire with the head office in London, one of the wires is used only for sending messages up to London, the other only for sending messages down, and there is no means of telegraphic communication between one country town and another, except through London. Let us further suppose that whenever a message from London is received in any town the town bell is rung; now if we give in a message at the Manchester office, intending it to go through London to every town in the country, and find that no bells are rung, it is obvious that something is wrong; it may be, first, that the apparatus at Manchester is out of order, so that the message was never sent; or, second, that the up wire from Manchester was broken or not insulated, so that the message never reached London; or, third, that there was something wrong at the head office; or, fourth, that all the down wires were broken or not insulated; or, fifth, that something was wrong at all the receiving offices throughout the country; or, sixth, that the bells could not be rung. When a healthy frog is pinched anywhere the animal jumps, a message is sent from the part of the skin pinched to the nerve-centres, and thence to all the muscles; but if we give the frog iodide of methyl-strychnium a pinch produces no effect. As in the supposed telegraphic case this result may be due to one of six causes,—first, the ends of the sensory nerves may be injured, so that the message is never sent from the place pinched; or, second, the sensory nerve-trunks may be paralysed, so that the message does not reach the nerve-centres; or, third, the nerve-centres may be so deranged that they do not send it on to the motor nerves; or, fourth, the motor nerve-trunks may be paralysed; or, fifth, the terminations of the motor nerves may be injured, so that they do not communicate the stimulus to the muscular fibres; or, sixth, the muscular fibres themselves may be incapable of contracting.

To return to the supposed telegraph case,—if we could ensure that the whole apparatus within some one county at a distance from London, say Cumberland, were in good order, and found that the bells rung in Cumberland, and nowhere else, when a message was sent from Manchester, we should know that the mischief was not in the apparatus for sending the up mes-

sage, nor in the up wires, nor in the head office, nor in the down wires, for to reach Cumberland the message had to pass through districts where the injury existed; the fault must be either at the receiving offices or in the bells. If now we can go directly to the bells throughout the country, and find that they can be rung, we prove the fault to lie at the receiving offices. In the case of the frog, we can, by tying the artery of one leg, prevent the poison from reaching that leg, which thus represents Cumberland in the case above; if the frog be now pinched *anywhere* he kicks with the unpoisoned leg, proving, as above, that the poison does not act on the terminations of the sensory nerves, nor on the trunks of the sensory nerves, nor on the nerve-centres, nor on the motor nerve-trunks, but that its action must be either on the terminations of the motor nerves, or on the muscular fibres. But we find that the muscles contract when directly stimulated, showing that they are not injured, and we thus prove that the paralysis is produced by a destruction of the power of the terminations of the motor nerves to receive the stimulus and transmit it to the muscles.

Strychnia produces tetanic convulsions, by exciting the nerve-centres in the spinal cord, but the substances formed by rendering the trebly-related nitrogen atom of strychnia permanently fivefold-related produce paralysis, and do so in the very remarkable way described above. Not only is this the case with strychnia, but we have found that the same change is produced in every alkaloid we have examined, which has an action like that of strychnia.

It will be seen that we have as yet made but little progress towards the solution of the very important question, What is the relation between chemical constitution and physiological action? We may, however, reasonably expect that a series of investigations, such as that sketched above, will throw a good deal of light on the subject.

ON THE RELATION BETWEEN THE MAGNETISM OF SOME METALS, AND THEIR ATOMIC AND SPECIFIC WEIGHTS.*

BY P. H. VAN DER WEYDE, M.D.

WHEN we divide the specific gravity of the different metals respectively into their atomic weights, we obtain quotients which indicate, not directly, but relatively, the distance of their atoms (upon the supposition that the atomic weights indicate really the relative weights of their atoms, which is only probable, but not proved): comparing those quotients in the subjoined table, we find the following remarkable results:—

	Sp. Gr.	Atomic Weight.	Quotient.
Cobalt	8.5	30	3.53†
Iron	7.8	28	3.52‡
Chromium.....	6.8	26	3.82§
Nickel	8	31	3.90||
Manganese.....	7	27.6	3.94¶
Palladium	11.8	53	4.49
Platinum.....	21.5	99	4.57
Zinc	6.8	32.5	4.78

* American Journal of Mining.

† Remains paramagnetic at white heat.

‡ Is not magnetic below bright red heat.

§ Is only magnetic below dark red heat.

|| Is only magnetic below 600° Fahr.

¶ Is only magnetic below 4° Fahr.

	Sp. Gr.	Atomic Weight.	Quotient.
Aluminium	2.56	13.7	5.35
Iridium	16	99	6.2
Cadmium.....	8.7	56	6.4
Magnesium....	1.74	12	7
Mercury.....	13.5	100	7.47
Lead.....	11.4	104	9.12
Osmium.....	10	100	10
Gold.....	19.4	196	10.005
Silver.....	10.47	108	10.3
Lithium.....	0.593	6.4	10.9
Antimony.....	6.7	130	19.4
Bismuth.....	9.8	208	21.22

Observations.

1st. The five magnetic metals have all quotients below 4.

2nd. The so-called non-magnetic metals have all quotients above 4.

There is, however, one exception to this rule, in the case of copper, of which the respective specific and atomic weights are 8.8 and 31.7, of which the quotient is 3.602; but then it is probable that the atomic weight of copper needs correction, and should be doubled to 63.4, in which case the quotient would be 7.204, and it would then fall among the other non-magnetic metals.

3rd. The quotients are the smallest for those metals which are the most permanently magnetic, even at high temperature, and *vice versa*.

4th. As cooling increases by contraction the number expressing the specific gravity, it will consequently decrease the quotient obtained by using this increased specific gravity as a divisor, in perfect accordance with the fact that cooling increases the paramagnetic property.

5th. As, inversely, heating decreases by expansion the specific gravity, it will increase this quotient, in accordance with the fact that heat diminishes paramagnetism, and finally destroys it in all metals with the single exception of cobalt, which has the smallest quotient of all, and consequently can stand some increase.

6th. The experiments of Faraday on diamagnetism and paramagnetism, with very powerful electro-magnets, have proved that palladium and platinum are the strongest paramagnetic next to the first five in the above list; they have in my list, also, the smallest quotients connected with them.

7th. In the same way as diamagnetism is the opposite of paramagnetism, the larger quotients in the above table belong to diamagnetic bodies, as, for instance, mercury, antimony, and bismuth. The last is the strongest diamagnetic substance experimented upon, and possesses the greatest quotient in the above table.

8th. If we were able to cool the other metals so as to increase their specific gravities to such a degree as to have a decided effect on the amount of this quotient, we might perhaps succeed in discovering in several of them paramagnetic qualities, by means of Faraday's apparatus.

9th. Heating decreases the paramagnetic qualities, with the specific weight, and consequently increases the quotient. That it may do this to such a degree as to make the body diamagnetic, is proved in the case of oxygen gas, which, when cool, is paramagnetic like iron, and when hot, diamagnetic like bismuth.

10th. That this relative distance of the atoms (upon which, of course, the specific gravity of bodies depends) is closely related to their magnetism, is again proved

by their crystals, which are always less dense in the direction of their optical axis, and expand by heat more in one direction than in another; and Pluecker has demonstrated that they are diamagnetic in the direction of their optical axis, or of the longest axis of crystallisation. In some of these crystals, this action is so strong that they are influenced by the magnetism of the earth; as, for instance, a properly cut crystal of kyanite (a dense silicate of alumina) when suspended on an axis, will behave like a compass needle, and may be used as such, a fact little known, but worth knowing.

ON THE ESTIMATION OF SULPHUR IN MINERALS CONTAINING IRON.

BY M. W. EGGERTZ,

PROFESSOR IN THE FAHLUN SCHOOL OF MINES.

FIVE grammes of the mineral, ground as finely as possible in an agate mortar, are treated with chlorate of potash and hydrochloric acid in the same manner as in the case of iron. After desiccation and the employment of hydrochloric acid and water, the insoluble substances may be sulphates of lead, lime, baryta, strontia, silicic acid, and undecomposed mineral. By stirring well and filtering the liquid whilst warm the two former salts likewise may generally, however, be dissolved.

The filtration should be performed through strong paper, or rather through a double filter, to prevent the pulverised mineral from passing through. When the clear portion of the solution has been poured upon the filter, add to the insoluble matter 5 c.c. of hydrochloric acid and 5 c.c. of water; then leave the mixture for two hours on the water-bath at a boiling temperature, and, if care be taken to stir well, the sulphate of lime will be completely dissolved. Wash the insoluble portion in warm water, and pour it on a filter, taking care to place below a flask specially to receive that portion of mineral which may have passed through the filter. The precipitation of the sulphuric acid is effected as already described.* After adding chloride of barium and cooling the solution, add 10 c.c. of ammonia.

To dissolve the sulphate of lead, which may occur in the insoluble portion, remove this from the filter with the end of a feather, introduce it into a flask, and pour over it 10 c.c. of concentrated acetate of ammonia. The solution after having been strongly agitated and heated in the water-bath, is carefully poured on to a filter. Then wash the residue with a little acetate of ammonia, and repeat the treatment until a few c.c. of solution, acidulated with a little acetic or hydrochloric acid, is not rendered turbid when warmed with chloride of barium solution. The filtrate is then diluted, slightly acidified, and the sulphuric acid precipitated by means of chloride of barium. After the sulphate of lead has been removed, there may still occur sulphates of baryta and strontia in the insoluble portion, although these have not hitherto been met with in the iron ores of Sweden. To decompose these salts the residues must be dried, heated to redness, and weighed, and then fused with five times their weight of pure dry soda. The mass is digested with water over a water-bath, the liquid filtered, and the residue washed with warm water. The silicic acid is separated from the solution, which contains the silicate, the carbonate, and the sulphate of soda, by adding

hydrochloric acid and drying on the water-bath. After filtering, precipitate the solution with chloride of barium.

To ascertain if the iron mineral contains gypsum or other soluble sulphates: take 5 grammes, place them in 20 c.c. of hydrochloric acid, and 60 c.c. of distilled water, and digest them for three hours on the water-bath, with frequent agitation. The filtered solution is mixed with chloride of barium and 15 c.c. of ammonia; then proceed as already described. If there are found in the mineral grains of iron or copper pyrites, or galena, their presence will only give in this operation traces of sulphene phuric acid.

To ascertain the accuracy of the process which has just been described, the following experiments have been made:—

I. A sulphide of iron (as usually employed in the preparation of sulphuretted hydrogen) was dissolved in the manner above described, in hydrochloric acid, water and chlorate of potash, in a flask furnished with a glass tube leading into a solution of sulphate of copper. No trace of precipitate, nor any colouration which would indicate the presence of sulphide of copper, could be detected in the solution; so that it is certain that no loss of sulphur could take place on dissolving iron or minerals in this manner.

When the experiment was repeated, but with this alteration, that the solution of chlorate of potash, during the addition of hydrochloric acid, was not kept well boiling, the sulphate of copper solution was rendered turbid, showing the necessity of resorting to complete ebullition.

II. The sulphide of iron treated in the same apparatus with aqua regia (composed of equal parts of nitric and hydrochloric acids) requires a more equal temperature and a stronger ebullition to prevent any precipitation of copper. Moreover, as the solution of iron by chlorate of potash takes place promptly, and as the presence of nitric acid is prejudicial both for the solution of the mass after drying in the water-bath (owing to the formation of subnitrate of iron), and also for the precipitation of the solution by chloride of barium, preference should be given to the employment of chlorate of potash.

III. One gramme of pure pyrites was treated in the above described manner, and the sulphur which separated at first was completely dissolved during the drying of the liquid on the water-bath. Upon precipitating with chloride of barium, a quantity of sulphate of baryta was obtained, exactly corresponding to the amount of sulphur in the pyrites.

IV. Many experiments were made with the filtered liquids obtained from solutions of iron which had been freed from sulphur by excess of chloride of barium. After standing for several days these have been brought to ebullition and mixed with 1 c.c. of an aqueous solution of sulphate of soda, containing a quantity of sulphuric acid, corresponding to 0.0001 gramme of sulphur. At the end of at least 24 hours a feeble precipitate is observed, which proves that the sulphuric acid is perfectly separated from the iron. This precipitate is rendered distinctly visible when the contents of the flask are stirred by moving a glass rod circularly round the liquid, for the sulphate of baryta then mounts in a small whirlpool and falls again on to one spot. When, also, 50 c.c. of the solution of sulphate of soda are added to the filtered liquids, the exact weight of sulphate of baryta has been obtained. If, in the filtered liquids, there were 10 c.c. of free hydrochloric instead of 5, two days sometimes elapse before the precipitate from the solu-

* See CHEMICAL NEWS, this Volume, No. 439, p. 207. (*Am. Repr.*, July, '68, page 1.)

tion (containing 1 c.c. of the sulphate of soda solution) becomes visible. Consequently if there are more than 5 c.c. of free hydrochloric acid in the solution, there must be added for each c.c. in excess (to the solution augmented by chloride of barium and then cooled) 1 c.c. of caustic ammonia, weighing 0.95 gramme, and the hydrochloric acid will be in this way nearly neutralised. The precipitation takes place more easily than when the iron solution is used, if 1 c.c. of the aqueous solution of sulphate of soda is added to a mixture of 150 c.c. of water and 5 c.c. of hydrochloric acid; this shows that the solution of the iron mineral renders the precipitation more difficult.

V. In many experiments in which the sulphate of baryta was washed for a long time on a filter, both with warm and cold water, it was impossible, upon evaporating a drop of the filtrate on a watch glass, to avoid traces being left on the latter. Some drops of a solution of chloride of barium and a little hydrochloric acid having been added to the filtrate always produced a feeble white precipitate by the action of the heat. For this reason the washing should only be continued until a drop of the washing water leaves on evaporation on glass an almost interceptible white ring.

VI. 4.9 grammes of carbonate of lime, and 0.1 gramme of pyrites submitted to the same process of solution gave by evaporation on the water-bath a perfectly clear solution; after drying, 6 c.c. of hydrochloric acid, and 50 c.c. of water were added to the residue, and there was thus obtained a considerable mass of gypsum. On leaving the liquid for an hour on the water-bath and increasing the quantity of water, the gypsum was completely dissolved.

0.1 gramme of gypsum was dissolved in 2 c.c. of hydrochloric acid and 4 or 6 c.c. of water (or better still in 10 c.c. of acetate of ammonia). The solution was left for half an hour on the water-bath with frequent agitation. It could then be diluted with water, at pleasure, without the gypsum being precipitated.

VII. 0.5 gramme of sulphide of lead (galena) were completely dissolved in the same manner, and the solution brought to dryness on the water-bath. A little water was added to remove the chloride of potassium, and evaporated after solution of this salt; the sulphate of lead which remained was then completely dissolved in 20 c.c. of acetate of ammonia, and precipitated with acetate of baryta containing a little free acetic acid. The sulphate of baryta, which was of the proper weight, was of a grey colour, but became whiter without alteration of weight by being heated to bright redness for some time with access of air.

0.1 gramme of sulphate of lead dissolves without rise of temperature in 2 c.c. of acetate of ammonia; chloride of lead dissolves in it still more easily. The solution may be diluted with water without any precipitation taking place.

0.1 gramme of sulphate of lead was dissolved on the water-bath by violent agitation for half an hour with 4 c.c. of hydrochloric acid (of 1.12 sp. gr.) diluted with 2 c.c. of water; but the sulphate commenced to crystallise as soon as the liquid was cooled to 60° or 70°.

VIII. 4.7 grammes of an iron mixture containing a known quantity of sulphur having been mixed with 0.1 gramme of pyrites, 0.1 gramme of sulphide of lead, and 0.1 gramme of gypsum, treated in the same manner as the iron mineral, gave exactly the quantity of sulphate of baryta which it should have yielded by theory. The precipitate from the solution in acetate of ammonia only weighed a few milligrammes.

IX. An aqueous solution of sulphate of soda, accurately standardised, and then chloride of barium, were added to a solution of soluble glass acidulated with hydrochloric acid. The weight of the sulphate of baryta which was formed showed that the gelatinous silicic acid in solution in the acid does not interfere in these experiments.

X. 0.1 gramme of pure quartz was fused with 0.5 gramme of anhydrous soda in a platinum crucible. The mass was completely soluble, without heating, in 5 c.c. of water, and the liquid remained clear even in the water-bath.

XI. 0.1 gramme of sulphate of baryta was fused in a platinum crucible with 0.5 gramme of carbonate of soda; the mass, treated with water, was poured upon a filter and washed. The carbonate of baryta remaining on the filter was brought to a red heat, and then dissolved in dilute hydrochloric acid without the least residue. The same experiment was tried with sulphate of strontia. It follows, therefore, that these two salts may be completely decomposed by fusion with carbonate of soda.—*Moniteur Scientifique*.

ON THE

ESTIMATION OF SULPHUR IN COAL GAS.*

BY WM. VALENTIN, ESQ.,

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In an article "On a New Method for Estimating Sulphur in Coal Gas," published in the *Journal of Gas Lighting* of January 7, 1868, I drew the attention of gas engineers to the defects of the method now generally in use for estimating the sulphur in gas. I stated that at some future time I would submit the two methods—viz., that described by me, which, for shortness' sake, I will call the *platinum process*, and the *lime (soda-lime) process*, to some further comparative experiments.

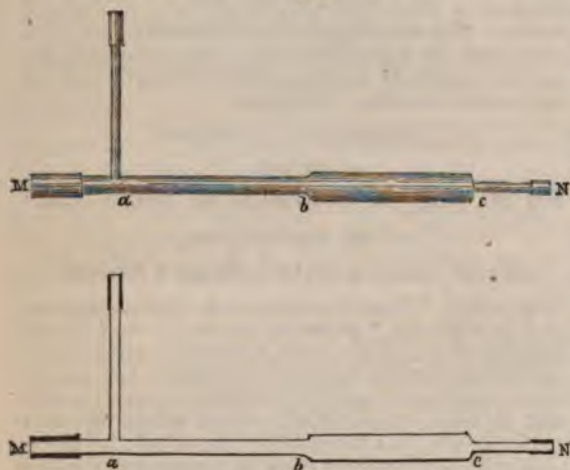
Since writing these lines I have had occasion to make a series of experiments on the estimation of sulphur, both in the form of volatile sulphur compounds and that of sulphates contained in grains, such as wheat, peas, beans, &c., and have for this purpose combined the two methods of combustion—viz., over spongy platinum and over pure soda-lime perfectly free from sulphuric acid. To effect this I employed a tube made of thin platinum, in which the combustion of the volatile sulphur compounds was accomplished by passing them over spongy platinum, and then over a layer of soda-lime. The air which was required to burn the volatile organic matter was supplied through a narrow platinum tube, which branched off from the main tube a little way anterior to where the layer of spongy platinum was placed. An aspirator drew the required amount of air through the tube, and by means of an adapter-tube and flask containing some solution of pure caustic soda, any sulphuric acid could be arrested that might possibly escape the absorptive and fixing action of the caustic alkalies placed in the platinum tube. After a number of most carefully conducted experiments, I satisfied myself that not a trace of sulphuric acid escaped from the platinum tube, and that, in fact, my precaution of having a solution of a powerful absorbing agent in front was superfluous. *Soda-lime absorbs and arrests every trace of sulphuric acid.* Acting upon

* Reprinted, by permission, from the *Journal of Gas Lighting*.

this observation, I at once adopted the same mode of proceeding for the estimation of the sulphur in coal gas. Thus, instead of carrying on a series of comparative experiments in order to establish the claims of the lime process over the platinum process—the so-called Letheby process, I believe, may be left out of consideration altogether, after the evidence that has been brought forward by various investigators, showing its utter worthlessness as a process for accurately estimating the sulphur in coal gas—I resolved upon combining the advantages of perfect and easy combustion possessed by the platinum process with those for complete absorption of the sulphuric acid held out by the soda-lime process.

To this end I employed a platinum tube,* MN, Fig. 1 ($\frac{1}{2}$ size), 13 inches in length, which could be heated on

FIG. 1.



a small Hofmann's combustion furnace, in the place of the porcelain tube described in a former article. The portion of the platinum tube marked *a b*, 5 inches in length and three-eighths of an inch in diameter, is charged with a cage constructed of a double roll of fine platinum gauze and filled with spongy platinum. The wider portion of the tube, *b c*, 4 inches in length and five-eighths of an inch in diameter, contains the soda-lime. The air requisite to completely burn the gas enters through a narrow glass tube, connected by means of a small cork at *M* with the wide end of the platinum tube. A cap of an alloy of silver and copper soldered to this part of the tube strengthens it sufficiently to prevent the thin platinum from being injured by a tightly fitting cork. The supply of gas to the tube passes through the narrow tube four inches long and three-sixteenths of an inch in diameter, likewise capped, which is seen to branch off at a right angle from the portion of the main tube next to the anterior part of the platinum cage containing the spongy platinum. The products of combustion are allowed to escape at *N*, through the narrow platinum tube *c N*. Connections for supplying gas and air are made by narrow non-vulcanised black india-rubber tubing.

I find it most convenient to supply the air under slight pressure by means of a gasholder, from which the air is expelled by displacement with water. Such

gasholders are found in most gas-works. A Low's motive-power meter may also be employed with great advantage, as it is capable of being regulated so as to give a supply of air sufficient for one experiment, whilst a small gasholder would require to be refilled with air once or twice during an experiment. The pressure from the gas-mains is at all times sufficient to send the gas through the platinum tube. The respective proportions of gas and air are best regulated by means of meters, when the pressure-gauge must of course show the same heights of water column, or the air may also be adjusted without having to pass through a meter merely by using a compression-cock on the narrow india-rubber tube, as described in a former paper.

Preparatory to an experiment the platinum tube is charged with pure soda-lime, by dropping in a lump sufficiently large to easily block up the narrow exit-tube. The whole of the wide portion of the tube, *b c*, is then gradually filled with loose pieces of soda-lime, of a size to enable the operator speedily to shake out the charge of soda-lime when the combustion is over. By gently tapping the platinum tube, held in an upright position whilst it is charged, the layer of soda lime shakes down pretty completely, and is yet sufficiently porous to allow of a free and easy passage for the gaseous products of the combustion. The cage of spongy platinum is next introduced, and pushed down past the narrow branch tube. The gas and air connections are then made, and the platinum tube is placed upon a small combustion furnace, and heat applied to it from *a* to *c* by turning on the required number of gas burners at once. The platinum tube is best protected from the action of the gas flames by being kept imbedded in asbestos loosely spread in a thin layer along a trough made of tinned sheet iron. The supply of gas to the clay gas-burners should at no time be so great as to cause flames to shoot up above the burners or the tiles which cover the furnace. A dull red heat is sufficient, especially as much heat is generated inside the platinum tube by the combustion of the gas and air within the pores of the spongy platinum.

From 5 to 1 cubic foot of gas can conveniently be burned per hour, requiring from 5 to 10 cubic feet of air for its complete combustion. An experiment can thus be done in three to four hours, since as a rule 2 to 4 cubic feet of gas burned in the manner described yield sufficient sulphuric acid for an accurate weighing in the form of sulphate of barium.

The experiment over, the tube is allowed to cool in a slow current of air alone. The two ends are disconnected, and the cage of spongy platinum drawn out by means of a copper wire having a little hook at one end. A stout bit of platinum wire in the form of a loop or ring may also be attached to the cage, for the more ready removal of the platinum cage. The latter is placed into a good-sized test-tube, and treated repeatedly with boiling distilled water, acidulated in the test-tube with a little dilute hydrochloric acid, in order to remove a little sulphuric acid which the spongy platinum retains. The soda-lime is next shaken out into a high beaker, and the tube washed out with hot dilute hydrochloric acid. This is most conveniently done by moving the platinum tube, held in a horizontal position, with its contents of dilute acid backwards and forwards in a small Bunsen gas flame. The rinsings are poured over the solid soda-lime contained in the beaker. Loss from spitting must be guarded against by rapidly covering the beaker with a large watch-glass after each addition of hydrochloric acid, as long

* I am indebted to my friend Mr. E. Matthey, of the firm of Messrs. Johnson and Matthey, of Hatton Garden, for a platinum apparatus of admirable make and great neatness.

as an effervescence takes place. The soda-lime is completely dissolved by the application of a gentle heat, and the carbonic acid must be entirely driven off before the sulphuric acid can be precipitated by means of a solution of chloride of barium. On gently heating for some time, the precipitate falls out readily and completely, and may be filtered off after standing for a short time, and ignited and weighed as sulphate of barium.

I need not explain that the sulphuric acid can also be estimated volumetrically by means of a standard solution of chloride of barium.

In conclusion, I will shortly point out the advantages of the new method * of estimating sulphur in coal gas over that now in use, and known as Dr. Letheby's sulphur test, viz. :—

1. Perfect combustion of the gas in a close vessel, at a very high temperature.
2. Complete and easy absorption of the sulphuric acid generated by the oxidation of the bisulphide of carbon, in the same vessel in which it was generated.
3. No loss from imperfect condensation.
4. Possibility of completing an experiment in a few hours' time, or, as seems most desirable, during the time of the evening when the greatest consumption of gas occurs.

ON SOME EFFECTS OF THE HEAT OF THE OXY-HYDROGEN FLAME.†

BY WILLIAM ODLING, M.B., F.R.S.

I.

CHEMICAL changes, whether of combination or decomposition, result in the production of new bodies which, under the conditions of the change, have for the most part a greater stability than the original bodies.

One evidence of this greater stability is afforded by the development of a quantity of heat—the heat of chemical action—from the produced bodies having a smaller potential heat than the original ones.

It results, both from reason and experiment, that in order to undo or reverse any definite chemical action, just so much heat must be directly or indirectly expended as was evolved by the original action.

For the same quantity of heat evolved, the resulting temperature varies with the mass and kind of matter heated, and with the rapid or gradual evolution of the heat.

When the evolution of heat is instantaneous, the resulting temperature may be calculated from the quantity of heat evolved, and the mass and specific heat, &c., of the matter heated.

By a unit of heat is meant the quantity of heat necessary to raise the temperature of one kilogramme of water one degree Centigrade, or more accurately from 0° to 1°.

II.

Every 18 grammes of water is a combination of two 1-gramme proportions of hydrogen H, with one 16-gramme proportion of oxygen O; and by the combination of two grammes of hydrogen with sixteen grammes of oxygen, there are developed 68 units of heat.

* Mr. Hartley, of the firm of Messrs. Wright and Co., 55, Millbank Street, Westminster, is prepared to supply the apparatus for the new sulphur test.

† A lecture delivered before the Royal Institution, Friday, May 22, 1863.

Of these 68 units of heat, however, little more than 57 units are really due to the chemical action,—nearly 11 units of heat being evolved by the contraction of the original mixed gas into two-thirds of its volume of steam, and by the further condensation of the resulting steam into 18 cubic centimetres of water.

While the quantity of heat evolved by the combination of a given quantity of oxygen and hydrogen is invariable, the intensity of the heat may vary from a scarcely recognisable rise of temperature up to the highest temperature of the oxy-hydrogen blowpipe flame, capable of fusing platinum and silica.

A most remarkable effect of the intense temperature resulting from the combination of oxygen and hydrogen into water, is the partial decomposition of water into oxygen and hydrogen, discovered by Mr. Grove in 1846.

At this high temperature, hydrochloric acid and carbonic anhydride gases also undergo partial decomposition, into hydrogen and chlorine, and into carbonous oxide and oxygen respectively.

Upon what do these singular decompositions by heat, of bodies formed with great evolution of heat, depend; or with what class of chemical phenomena may they be associated?

III.

Under certain familiar conditions, chemical action seemingly takes place to its utmost possible extent in a single direction only, with production of a maximum amount of the substance that is formed with maximum evolution of heat.

For example, taking atomic proportions in grammes, the heat of formation of chloride of zinc, $ZnCl_2$, is 101 units, and the heat of formation of chloride of copper, $CuCl_2$, is 60.5 units. Hence, with chlorine in solution and excess of both copper and zinc, there is finally produced the maximum possible amount of chloride of zinc and no chloride of copper.

Again, an addition of sufficient zinc to solution of chloride of copper, there is complete combination of chlorine with zinc and complete separation of chlorine from copper, i.e. complete burning of the one metal and complete unburning of the other.

IV.

But under simpler though less familiar conditions, chemical action habitually takes place in more than one direction simultaneously, with production of correlative products in varying proportions.

Thus, with hydrogen and excess of both chlorine and oxygen, although the heat of formation of oxide of hydrogen H_2O is 57 units, and the heat of formation of chloride of hydrogen $2HCl$ is only 47.5 units, yet, in this case, the hydrogen does not combine with the oxygen to the exclusion of the chlorine, but divides itself between the oxygen and the chlorine in proportions which vary with the conditions of the experiment.

In accordance with this result it is found that, at the same red heat, excess of chlorine will effect the partial decomposition of water with extrusion of oxygen; and conversely, that excess of oxygen will effect the partial decomposition of hydrochloric acid with extrusion of chlorine.

So that, beginning with the two chemical substances, water and chlorine, or beginning with the two chemical substances, hydrochloric acid and oxygen, or beginning with the three chemical substances, hydrogen, chlorine, and oxygen, there exist, at a full red heat, the four chemical substances, water, hydrochloric acid, chlorine,

and oxygen; the proportions of the four substances depending certainly upon the relative quantities present of the elements concerned, and most probably also upon the temperature of the experiment.

Similarly, beginning with the one chemical substance, water (Grove), or beginning with the two chemical substances, oxygen and hydrogen (Bunsen), there always exist, at a sufficiently high temperature, the three chemical substances, water, oxygen, and hydrogen.

Although, by exposure to a red heat, the electrolytic mixture of oxygen and hydrogen gases becomes completely combined, or transformed into water, yet, as recently shown by Bunsen, at the high temperature of 2024 degrees, only one-half, and at the still higher temperature of 2844 degrees, only one-third of the mixture undergoes combination, the other one-half or two-thirds remaining in the state of mixed gas.

V.

Chemists are acquainted with many reciprocal actions comparable with those of chlorine upon water, and of oxygen upon hydrochloric acid, the most familiar instance being probably the decomposition of ignited oxide of iron by hydrogen with extrusion of iron, and the converse decomposition of oxide of hydrogen by ignited iron with extrusion of hydrogen.

Similarly, sodium will decompose the oxides of carbon, while carbon will decompose oxide of sodium; and just as a sufficient excess of chlorine may be made to effect the almost complete decomposition of a given quantity of water, so may a sufficient excess of carbon (or carbonous oxide) be made to effect the almost complete decomposition of a given quantity of sodium oxide or zinc-oxide, as in the ordinary processes for obtaining the two metals; notwithstanding that, for an equal consumption of oxygen, the respective combination heats of sodium and zinc exceed by far the combination heat of carbon or carbonous oxide.

Again, although the combination heat of oxygen and carbonous oxide is 68 units, while that of oxygen and hydrogen is only 57 units, yet, as was shown by Bunsen many years ago, upon exploding a mixture of oxygen with a joint excess of carbonous oxide and hydrogen, the oxygen does not attach itself exclusively to the carbonous oxide, but divides it-elf between the carbonous oxide and hydrogen in a ratio determined by their relative proportions.

EXPERIMENTS WITH PAPER FILTERS.

BY CHARLES E. AVERY,

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THE filter most commonly employed in analytical laboratories is a circular piece of paper folded twice upon itself into the form of a quadrant, and supported on a glass funnel with straight sides. This filter, though commendable in so far as it is capable of supporting the weight of a considerable column of liquid without breaking, is objectionable, inasmuch as liquids cannot pass through it so rapidly as is desirable. Since at almost every point the paper is in close contact with the glass, but little of the liquid can flow off between the filter and the sides of the funnel.

Several schemes have at various times been proposed for opening water-ways between the glass and the paper; the interposition of straws, glass rods and splinters of wood between filter and funnel, as well as fluted fun-

nels and plaited filters, are all devices looking to this end.

The advantages of the plaited filter are so great that some chemists prefer to use it, even in quantitative analysis, instead of the common form, in spite of its greater liability to break, and the difficulty of washing the precipitate.

In the laboratories of Profs. Lawrence Smith and Ordway, among the most accurate of American analysts, plaited filters are said to be employed to the almost total exclusion of the plain form.

Another excellent method of increasing the speed of filtration, first suggested in America by the German chemist Fleitman, consists in placing one plain filter within another of coarser fibre; for instance a fine plain filter of Swedish paper may be placed within another plain filter of coarse German paper, supported as usual on a funnel.

In experimenting upon these various forms of filters, it occurred to me to fold the plain qualitative filter in two operations instead of one. In place of folding the filter doubled upon itself down the middle in the usual way, I proposed to turn down on each side of the paper a fold equal to one-quarter of the semicircle, and then to fold the sectors of 45° arc thus formed back upon themselves.

The filter is then opened without disturbing the folded portions, and placed upon the funnel. In this form the triple side of the plain filter is broken up, and the folded portions keep open passages instead of hindering filtration.

This filter, as tried against the plain form, gave 1st, 133 : 100. 2nd, 111 + : 100. 3rd, 205 + : 100.

Two plain filters ran equally in several trials; each was changed into the other's funnel, and No. 1 ran 33 per cent less than No. 2. No. 1 was dried and folded into my form; remaining in the same funnel, it ran 32 per cent faster than the other. Both filters were then opened, and showed no tear or weakness when held against the light.

As these filters gave different results in different funnels, I thought I would ascertain the cause. The water seemed to be retarded in its passage by the attraction of the glass; therefore, those funnels having the greater portions of the paper free from the glass would be the best; that is, a *broad-throated funnel*, other things being equal, will filter faster than a *narrow-throated funnel*.

To test this point I selected two large funnels; No. 1 had three times as broad a throat as No. 2. With the first filters they ran:

117 : 100 123 : 100 133 : 100 118 : 100

The reason for this low difference was found in a thin spot near the point of No. 2.

Other sets of filters gave:

2nd set	292 : 100	318 : 100
3rd set	288 : 100	335 : 100
4th set	300 : 100	burst.
5th set	384 : 100	407 : 100 482 : 100
6th set	242 : 100	

In the last set a porous filter, though off the same sheet as No. 1, was given to No. 2. Throughout the whole series of experiments every fair advantage was given to the weaker party, it being the first filled and the last emptied.

To make assurance doubly sure, I tried filters in like funnels, stopping the pores of the paper at various

points. Paraffin applied whilst liquid was the substance first used to prevent filtration.

Two filters were chosen from the same sheet and of as uniform a texture as possible. No. 1 was stopped over one-third of the radius from the point. No 2, all but one-third the radius at the point.

They filtered at nearly the same rate, No. 1 slightly the faster. The paraffin made the paper stiff, and as water does not adhere to it, free passage was allowed between it and the funnel to the water of the upper part of No. 2.

Here we see that one-ninth of the surface of the filter, when free, did as much work as eight-ninths adherent to the glass. The experiment was repeated by glycerin instead of paraffin. No. 1 ran 28 per cent the faster. It might be objected that glycerin would wash out; so a pap of paraffin and spirits of turpentine was used to repeat the experiments. Each filter, after being painted, was wetted to prevent the spread of the mixture by capillary action. The trials were not sufficiently numerous to find a true mean, but the free point invariably ran the most—from 4 or 5 per cent excess to 100 per cent. The point was assumed to be a circle one-third the radius of the filter.

I understood the idea of the Fleitmann filter to be this, that, likening a plain filter to a peat bed resting upon an impermeable subsoil, it might be compared to a porous substratum interpolated between the swamp and the clay bottom.

To test this idea a Fleitmann filter was made and wetted, carefully patting down and smoothing out any irregularities. It was tried against a plain filter which was placed in a funnel with but two-thirds as wide a throat as that of the Fleitmann. It ran 114 : 100; that is, the passages kept open by the elasticity of the paper, the creases and abutting edges liken this filter to tile drainage.

To increase the size and number of passages I tried putting the inner filter into a plaited filter of coarse paper. Changing the filters after each trial, I found this form gave the following result as compared with the plain filter, calling the latter one hundred.

1st trial	184 : 100.	4th trial	166 : 100
2nd "	201 : 100	5th "	170 : 100
3rd "	250 : 100		

I afterwards found a thin spot in the plain filter of the fourth trial.

Next a precipitate of sulphate of calcium was tried; filtrates were as 131 : 100. On weighing the precipitates collected they were as 200 : 100.

This form of filter was abandoned, since it does not filter as fast, is not as strong, takes more time to make and care to use than the form next to be described. It is, however, better than the plain filter as regards speed of filtration, equal to the plaited in this respect, and stronger than it.

To admit the use of very broad-throated funnels the number of outside filters was increased to two; these over-coats were pierced with long narrow apertures running from the point to the circumference.

In the following experiments, the improved filter was tried against the *plaited*. The improved filter, on account of its great strength, was allowed a funnel with a throat once and a half as broad as that given to the plaited filter. It would have borne one three times as broad.

1st trial	121 : 100	3rd trial	112 : 200
2nd "	125 : 100.	4th "	115 : 100

The fifth trial was made with a precipitate of sulphate of calcium; the filtrates were 82 : 100. Here the new filter seemed at fault, but on weighing the precipitates collected they were as 140 : 100. The new filter being last filled, got the thicker portions each time, whilst the plaited filter got the weak top liquor.

The outer jacket is cut by folding the filter as a plain filter and taking out a sliver on each edge; repeating the process increases the number of apertures. If the filters are to be used double, as in broad-throated funnels, the opening should extend nearly to the vertex; if they are used single, in common funnels the openings need not extend so far, and the extreme point may be removed.

A thick porous felt might be used for acid liquids as an outer filter. Cotton cloth would serve in alkaline solutions; gun-cotton could be used with either. If asbestos cloth could be procured it would probably be the best. It might be cleansed by burning, and would be unaffected by anything likely to be filtered in quantitative analysis, nor would it harm the filtrate when estimations are to be made by permanganate of potassium.

Most coarse filter paper is "stuffed" with mineral matter; such paper must of course be washed in acidulated water before being used for quantitative work, where the filtrate is to be saved.

When the precipitate is dry, the outer filters are thrown away, only the fine inner filter being burned.

Plaited and plain filters were tried in like funnels; calling the plaited filters No. 1, we had:

	I.	II.		I.	II.
1st trial	116 : 100		3rd trial	236 : 100	
2nd "	237 : 100		4th "	136 : 100	
5th "	"with sulphate of calcium precipitate, 231 : 100 the precipitates weighed 166 : 100.				

I then tried plain filters off the same sheet against each other in like funnels; usually the results varied but a few per cent, though sometimes much more; the greatest difference noticed was 2 to 1; several times the results corresponded exactly on repeated runs of 500 cubic centimetres.

Experiments were made to determine the difference in efficiency between the single and the triple sides of filters. No. 1 had its triple side covered with paraffin, leaving the single side free. No. 2 had the triple side free, while the single was covered; with paraffin the result was 175 : 100; glycerin was then tried with the result 200 : 100, showing the additional paper considerably retarded the flow.

I thought, since the adhesion of the water to the glass is the cause of slow filtration, I might increase the flow by coating the funnels on the inside with paraffin, to which water does not adhere. No. 1, being coated, No. 2, left clean, I got:

	I.	II.		I.	II.
1st trial	200 : 100		3rd trial	100 : 100	
2nd "	184 : 100		4th "	137 : 100	

The filters in the third and fourth trials were the same, but the funnels were changed about.

The outside or skeleton filters, above described, may be cut the same size as the inner filter; if much smaller the upper part of the inner filter clings to the glass; if larger a part of the precipitate is liable to adhere to the outer filter, and even with great care a part of the precipitate would creep up and be lost.—*American Journal of Pharmacy.*

EXPLOSION OF NITROGLYCERINE AT SYDNEY, NEW SOUTH WALES.

WE have received the report of the Board appointed to enquire into the origin and causes of an explosion which occurred at Sydney, on the 4th of March, which is so full and comprehensive that we have made some extracts from it, for those of our readers who are interested in the subject. A case, containing 100 lbs. of nitroglycerine, had been sent from Messrs. Nobel and Co., of Hamburg, to Mr. Winckler, of Sydney, to whom they had offered the agency. It was laid in a cellar where there was no gas or anything of an explosive nature; but about four days after, this disastrous event occurred. In seeking for the cause of the explosion, the Board, consisting of the Hon. A. Campbell, M.L.C.; Professor J. Smith, M.D., of Sydney University; and Capt. J. McLerie, Inspector-General of Police, reviewed the following suppositions:

(a). Some burglar may have entered the cellar, and in trying to break open the case, in the hope of finding spirits, may have caused the oil to explode. But if so, some remains of a human body would certainly have been found; and besides it would have been difficult to break into the cellar, and there was nothing to tempt a burglar.

(b). Something may have taken fire in the premises and communicated to the oil. But if so, some sign of combustion must have remained besides the charring of the gunny-bags. There were no gunny-bags in the cellar; none, in fact, but in the loft above the store; and we may account for two or three being partially burnt by supposing that the small sample bottles of gunpowder had been broken and ignited by the explosion, and had then ignited the bags; or a box of matches may have been ignited and scattered among them. Whatever caused the charring of the gunny-bags, we are certain that they did not cause the explosion, nor were directly ignited by the explosion; they must have been ignited indirectly, and probably in one of the ways above indicated.

(c). The oil may have been exploded by a blow or concussion, as it is admitted by the manufacturers that a blow under certain conditions will cause an explosion. We can imagine only two ways in which such a blow could be given, supposing it proved that no person was in the cellar at the time. First, a stone may have been thrown in from the street; but this is impossible from the relative positions of the window and the box. Second, a heavy body may have fallen on the box. The only thing we could discover that could have fallen on it, was an upright post supporting one of the beams; but a careful inspection showed clearly that this post had been blown away from where it stood, the base being dislodged before the top, and breaking away a portion of the stone on which it had rested.

(d). The high temperature to which the oil was subjected in the cellar may have caused some sort of fermentation resulting in explosion. It is asserted by the patentees that it will not explode by the application of a lighted match, but that it will by a temperature of about 360° . But it may be conceived that a much lower temperature may cause a sort of fermentation ending in the same result. But this cellar was cool and well ventilated. The temperature of the air, on the 3rd and 4th of March, was not higher than 77° , and the cellar must have been several degrees lower; on the 22nd it was not higher than 75° , and on the 1st *thru* $71\frac{1}{2}^{\circ}$. The oil must have been subjected to a

higher temperature within the tropics; and on the day on which it was landed and taken to the Queen's Warehouse the temperature at the Observatory rose to 101° in the shade.

They then report as follows:—

Having thus examined and dismissed various supposable external causes of the explosion, we are impelled to the conclusion that the cause lay within the oil itself—in other words, that it exploded spontaneously. This we allow is an unsatisfactory conclusion, and to many it may appear inadmissible. How, it may be asked, could this oil stand the rough handling and the vicissitudes of temperature that must have attended its progress from Hamburg to Sydney, and then, three days after being quietly deposited in a cool cellar, without any new condition supervening, spontaneously explode. Every effect must have a sufficient cause. To speak of this oil as exploding of its own accord, without external agency, is to endow it with a kind of conscious volition, leading it as it were to commit suicide! We admit the force of the objection, but call attention to the following considerations:—In a complex organic fluid like nitroglycerine, it is clear that the atoms are not in a condition of stable equilibrium,—their strongest chemical affinities are not satisfied—they are held together by some constraint, so to speak—in what we may call an unnatural sort of combination, and out of this combination they have a constant tendency to spring, and rearrange themselves in accordance with their stronger proclivities. For example, we know that oxygen has a much stronger attraction for carbon and for hydrogen than it has for nitrogen, and when the chemical affinities of these are fully satisfied, the carbon would be converted into carbonic acid, and the hydrogen into water in each case by union with oxygen; but in this nitroglycerine there is no carbonic acid or water, and there is good reason for believing that most of the oxygen is combined with nitrogen—hence the justification of the expression used above—that we have here an unnatural sort of combination, in which the stronger attractions are unsatisfied; and these unsatisfied attractions are really the source of the enormous potential energy locked up in the blasting oil.

Further, it is believed that the ultimate particles of all bodies (even the most solid) are in a state of continual motion, and this motion, in the case of compounds in a state of unstable equilibrium, tends to bring about, sooner or later, a condition of stable equilibrium, where the preponderating attractions are satisfied. Such changes (which are familiar to chemists) are usually slow and silent, but sometimes they are sudden and violent. In the case before us we have said that the particles are held by some constraint in an unnatural position; now, it is conceivable that, by the molecular motions spoken of, the constraining force is gradually weakened, until a period comes when it can no longer resist the strong affinities of the atoms, and they rush together suddenly, producing an enormous bulk of gaseous compounds at a very high temperature, and thus developing an immense mechanical force. If we suppose a strong spring to be kept down by a piece of wood in a condition of slow decay, it is clear that, sooner or later—though months or years may elapse—a moment must arrive when the restraining force must give way, and the spring will suddenly develop its long pent-up energy.

It is possible that the changes thus indicated in the nitroglycerine may have been promoted by the high

temperature to which it must have been subjected during the voyage, and after its arrival in Sydney; and perhaps in a cooler climate it might be safely kept for an indefinite time; though there is reason to suspect that an explosion of nitroglycerine, mentioned in the newspapers as having occurred last November in Westphalia, was also spontaneous, or without external agency.

As to the question of culpability in connection with this remarkable accident, we have come to the conclusion that no one is particularly to blame. The importers had reason to believe that the blasting oil was not more dangerous than gunpowder, if so much so; and the quantity did not exceed what they would have been authorized by law to store of gunpowder; but among the dozen of Colonial Acts that affect gunpowder, we do not find one that affects the quantity that may be stored of any other explosive substance. Then there was no concealment of the nature of this substance. We find that the "sight entry" describes the cases as containing "blasting oil," and Mr. Winckler explained to the Collector of Customs that it was a substitute for blasting powder. No doubt there was an infringement of the Colonial Act 18 Victoria, No. 21, which provides that no gunpowder, or other explosive material, shall be shipped or delivered, without a plain and durable brand or superscription on the package, showing the nature and quantity of the contents; but who could be proceeded against? The shippers are not in our power, and the captain of the ship that "delivered" the cases knew them only as containing "merchandise." But, supposing the case had been legibly marked "blasting oil," there is no reason to suppose that it would have been treated otherwise than it was; for the above-named Act provides only for the branding, and no other Act that we can find refers at all to other explosive materials than gunpowder.

In regard to the expected importation of 200 lbs. of nitroglycerine, we adopt and recommend the suggestion of the Collector of Customs—that the ship having this substance on board should not be allowed to come further up the harbour than Fort Denison, until the nitroglycerine be either thrown overboard, or landed on some unpeopled spot; and we further recommend to the Government to take such steps as may be necessary to ascertain, before arrival, the name of the ship by which this substance has been sent, and to give due warning and instructions to the pilots.

The question of the storage of future importations has engaged our special attention. It may turn out to be a question of no practical importance, as we hope that the serious accident that has occurred will have the effect of altogether stopping importations; but in the mean time we recommend that an Act should be passed without delay, providing that no nitroglycerine shall be kept in any inhabited house, and that no quantity greater than two pounds shall be stored under any one roof within the city or suburbs unless it be over 100 yards from any inhabited house; and that no quantity greater than 10 lbs. shall be stored within 300 yards of any inhabited house or public thoroughfare. Quantities greater than 10 lbs. must not be stored within the city or suburbs, but must be placed in a proper magazine, in such a position, and at such a distance from habitations or thoroughfares, as would ensure the public safety.

RELATIVE VALUES OF FRENCH AND ENGLISH WEIGHTS AND MEASURES.

BY A. A. PESQUET.

WEIGHTS.

Milligramme.....	=	0.015438395	troy grain
Centigramme.....	"	0.15438395	" "
Decigramme.....	"	1.5438395	" "
Gramme.....	"	15.438395	" grains
"	"	0.643	pennyweight
"	"	0.03216	oz. troy
"	"	0.03527	oz. avoirdupois
Decigramme	"	15.438395	troy grains
"	"	5.64	drams avoirdupois
Hectogramme	"	3.2154	oz. troy
"	"	3.527	oz. avoirdupois
Kilogramme	"	2.6803	lb. troy
"	"	2.205486	lb. avoirdupois
Myriagramme ...	"	26.803	lb. troy
"	"	22.05486	lb. avoirdupois
Quintal metrique..	"	100 kilog.	= 220.5486 lb. avoird.
Tonne	"	1000	" 2205.486 "

Different authors give the following values for the gramme:—

Gramme =	15.44402	troy grains
" "	15.44242	"
" "	15.4402	"
" "	15.433159	"
" "	15.432	"

AVOIRDUPOIS.

Long ton = 20 cwt.	= 2240 lb.	= 1015.649	kilogrammes
Short ton (2000 lb.).....	"	906.8296	"
Hundredweight (112 lb.)....	"	50.78245	"
Quarter (28 lb.).....	"	12.6956144	"
Pound = 16 oz.	= 7000 gr.	453.4148	grammes
Ounce " 16 drams	= 437.5 gr.	28.3375	"
Dram " 27.344 grains	"	1.77108	gramme

Troy (precious metals).

Pound = 12 oz.	= 5760 gr.	= 373.096	grammes
Ounce " 20 dwt.	= 480 " "	31.0913	"
Pennyweight... " 24	" "	1.55457	gramme
Grain..... "	" "	0.064773	"

Troy (pharmacy).

Ounce = 8 drams	= 480 gr.	= 31.0913	grammes
Dram " 3 scruples	= 60 " "	3.8869	"
Scruple "	= 20 " "	1.29546	gramme

CARAT WEIGHT FOR DIAMONDS.

1 carat = 4 carat grains	= 64 carat parts
" " 3.2	troy grains
" " 3.273	"
" " 0.207264	gramme
" " 0.212	"
" " 0.205	"

Great diversity in value.

SYMBOLS FOR ABBREVIATIONS.

Unit	metre	m.	gramme	g.	litre	l.	are	a
M Myria	Mm		Mg		MI			
K Kilo	Km		Kg		Kl			
H Hecto	Hm		Hg		Hl			Ha
D Deca	Dm		Dg		Dl			Da
d deci	dm		dg		dl			da
c centi	cm		cg		cl			ca
m milli	mm		mg		ml			

Km = kilometre. Hl = hectolitre.

—3

cg = centigramme. c.cm = cm = cubic centimetre.

—2

dm = sq. dm = square decimetre.

kgm = kilogrammetre.

kg° = kilogramme degree.

No. of Units.	Francs into Shillings.	Pence into Centimes.	Shillings into Francs.	Pounds sterling into Francs.
1.	0.79365	10.5033	1.2604	25.2080
2.	1.58730	21.0066	2.5208	50.4160
3.	2.38095	31.5099	3.7812	75.6240
4.	3.17460	42.0132	5.0416	100.8320
5.	3.96825	52.5165	6.3020	126.0400
6.	4.76190	63.0198	7.5624	151.2480
7.	5.55555	73.5231	8.8228	176.4560
8.	6.34920	84.0264	10.0832	201.6640
9.	7.14285	94.5297	11.3436	226.8720
10.	7.93650	105.0330	12.6040	252.0800

Conventional value of 1 shilling..... = 1.26 franc.

Mint value (previous to 1818)..... " 1.24 "

" (after 1818)..... " 1.16 "

1 franc = 100 centimes = 20 sous.

5 centimes = 1 sou. 10 centimes = 1 decime = 2 sou.

No. of Units.	Inches into Centimetres.	Feet into Metres.	Miles into Kilometres.
1.	2.539954	0.3047945	1.6093
2.	5.0799	0.6095890	3.2186
3.	7.6199	0.9143835	4.8279
4.	10.1598	1.2197680	6.4373
5.	12.6998	1.5239724	8.0466
6.	15.2397	1.8287669	9.6559
7.	17.7797	2.1335614	11.2652
8.	20.3196	2.4383559	12.8745
9.	22.8596	2.7431504	14.4838
10.	25.3995	3.0479450	16.0930

No. of Units.	Square Ft. into Square Metres.	Cubic Ft. into Cubic Metres.	Pounds per square Inch into Kilogrammes per square Centimetre.
1.	0.09290	0.028314	0.0702774
2.	0.18580	0.056628	0.1405548
3.	0.27870	0.084942	0.2108322
4.	0.37160	0.113256	0.2811096
5.	0.46450	0.141570	0.3513870
6.	0.55740	0.169884	0.4216644
7.	0.65030	0.198198	0.4919418
8.	0.74320	0.226512	0.5622192
9.	0.83610	0.254826	0.6324966
10.	0.92900	0.283140	0.7027740

No. of Units.	Kilogrammes per sq. Millimetre into Pounds per sq. Inch.	Pounds into Kilogrammes.	Long Tons into Tonnes of 1000 Kilog.
1.	1425.45	0.4534148	1.015649
2.	2850.90	0.9068296	2.031298
3.	4276.35	1.3602444	3.046947
4.	5701.80	1.8136592	4.062596
5.	7127.25	2.2670740	5.078245
6.	8552.70	2.7204888	6.093894
7.	9978.15	3.1739036	7.109543
8.	11403.60	3.6273184	8.125192
9.	12829.05	4.0807332	9.140841
10.	14254.50	4.5341480	10.156490

THERMOMETERS.

Celsius or Centigrade.	Fahrenheit.	Réaumur.
- 15° C	+ 5° F	- 12° R
" 10	" 14	" 8
" 5	" 23	" 4
" 0	" 32	" 0
+ 5	" 41	+ 4
" 10	" 50	" 8
" 15	" 59	" 12
" 20	" 68	" 16
" 25	" 77	" 20
" 30	" 86	" 24
" 35	" 95	" 28
" 40	" 104	" 32
" 45	" 113	" 36
" 50	" 122	" 40
" 55	" 131	" 44
" 60	" 140	" 48

Celsius or Centigrade.	Fahrenheit.	Réaumur.
+ 65° C	+ 149° F	+ 52° R
" 70	" 158	" 56
" 75	" 167	" 60
" 80	" 176	" 64
" 85	" 185	" 68
" 90	" 194	" 72
" 95	" 203	" 76
" 100	" 212	" 80

$$1^{\circ} \text{C} = 1.8^{\circ} \text{F} = \frac{9}{5}^{\circ} \text{F} = 0.8^{\circ} \text{R} = \frac{4}{5}^{\circ} \text{R}$$

$$1^{\circ} \text{C} \times \frac{9}{5} = 1^{\circ} \text{F} \quad 1^{\circ} \text{F} \times \frac{5}{9} = 1^{\circ} \text{C} \quad 1^{\circ} \text{R} \times \frac{5}{4} = 1^{\circ} \text{F} \quad 1^{\circ} \text{C} \times \frac{4}{5} = 1^{\circ} \text{R} \quad 1^{\circ} \text{F} \times \frac{4}{9} = 1^{\circ} \text{R} \quad 1^{\circ} \text{R} \times \frac{9}{4} = 1^{\circ} \text{F}$$

Caloric = Unit of heat.

" " Kilogramme degree = Kg°.

It is the quantity of heat necessary to raise of 1° C, the temperature of 1 Kilogramme of distilled water.

Kilogramme = Kgm. = the power necessary to raise 1 Kilogramme 1 metre high in 1 second. It is equal to $\frac{1}{7.5}$ of a French horse-power.

OBSERVATIONS ON FERRIC HYDRATE.

BY PROFESSOR ATTFIELD, PH.D.

IN a memoir in the CHEMICAL NEWS of June 12 (*Amer. Repr.*, Aug. '68, page 91) recently presented to the Academy of Sciences, M. Jeannel, in allusion to the fact that ferric hydrate is not always soluble in acids, states that the incomplete solubility is, in his opinion, generally due to the influence of traces of sulphates. He says, according to the Paris correspondent of the CHEMICAL NEWS, "sesquioxide, precipitated from the persulphate, is always to a certain extent insoluble, or yields unstable salts; the same is the case with the sesquioxide precipitated from the perchloride, when this has been contaminated by sulphuric acid, or equally when the alkalis employed as precipitants have been so contaminated, or, finally, when the ferric hydrate, precipitated from pure solutions by pure alkalis, has been washed with common water." This explanation does not accord with my experience of the properties of ferric hydrate and oxyhydrates. Firstly, in England the ferric citrates and tartrates used in medicine are successfully made in large quantities by dissolving ferric hydrate, prepared from ferric sulphate, in solutions of the respective acids and acid-salts. Secondly, I have frequently seen moist ferric hydrate perfectly dissolve in solutions of acids or acid-salts, even though the precipitate has been washed with common water containing sulphate of calcium, a final washing with distilled water having, for various reasons, been neglected. Thirdly, I have often noticed that pure ferric hydrate, soluble when freshly precipitated, becomes imperfectly so if long kept, moist or dry. It is true that when alkali is added to solution of ferric sulphate, instead of the latter to the former, an insoluble oxysulphate is precipitated, and a similar compound may, possibly, be formed under other circumstances; but ferric hydrate, properly prepared and fairly washed, is readily soluble if only it be used in the moist and recently-precipitated condition, with a solution of acid or acid-salt which is not too weak, and the mixture be not boiled or even strongly heated for any considerable length of time. The fact is that ferric hydrate, even though kept under water, decomposes after a time, or more quickly if heated, losing the elements of water and becoming an

oxyhydrate, a body insoluble in weak acids and, also unlike ferric hydrate, incapable of acting as an antidote to arsenic, that is, incapable of forming ferrous arseniate.

It may be useful again to draw attention to the decided alteration in properties which ferric hydrate spontaneously undergoes when exposed beneath the surface of water or when boiled with water, as evidence that this substance ($\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$) is a true analogue of hydrate of sodium (NaOH), &c., and not a hydrous ferric oxide ($\text{Fe}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$). It is more reasonable to suppose that in acquiring new properties ferric hydrate becomes changed to new compounds than to consider that the changes result from the loss of a portion of water already existing as water. Between ferric hydrate ($\text{Fe}_2\text{O}_3 \cdot \text{H}_2\text{O}$) and ferric oxide (Fe_2O_3) there would appear to be several oxyhydrates, analyses, &c., of most of which have already been given in the *CHEMICAL NEWS* (xvii. 56, *American Repr.*, March, 1868, page 114) by Brush and Rodman.

1. $\text{Fe}_2\text{O}_3 \cdot 12\text{H}_2\text{O}$.
2. $\text{Fe}_2\text{O}_3 \cdot 10\text{H}_2\text{O}$.
3. $\text{Fe}_2\text{O}_3 \cdot 8\text{H}_2\text{O}$.
4. $\text{Fe}_2\text{O}_3 \cdot 6\text{H}_2\text{O}$.
5. $\text{Fe}_2\text{O}_3 \cdot 4\text{H}_2\text{O}$.
6. $\text{Fe}_2\text{O}_3 \cdot 2\text{H}_2\text{O}$.
7. Fe_2O_3 .

In the above formulae, No. 1 represents two molecules of ferric hydrate; Church found a stalactite of true ferric hydrate, native, in Cornwall, and Wittstein gives a similar formula to fresh artificial ferric hydrate. No. 2 is the only oxyhydrate, in this series, still unknown, unless, indeed, Haughton's Kilbride mineral contains this body. No. 3 is brown iron ore from the Hüttenrode Harz. No. 4 is the formula of a limonite and of artificial ferric hydrate altered by age—described by Wittstein as having a crystalline structure. No. 5 is the mineral gothite, and also the dried oxyhydrate commonly used in pharmacy. No. 6 is turgite, hydrohæmatite, or the mineral from Salisbury, Conn., analysed by Brush and Rodman. No. 7 represents two molecules of ferric oxide.

ON THE

RESOLUTION OF THE SOUNDING FLAME.*

BY PROF. FRANCIS H. SMITH.

By those who have no mirrors, lenses, or revolving apparatus, and who find a difficulty in properly moving the eyes to and fro before the flame, the intermittent character of the latter, when sounding, may be exhibited by simply shaking a chalk crayon near it, and noting the marked change assumed in the appearance when the flame passes from silence to song.

With a revolving apparatus, however, the following form of experiment will be found satisfactory:—To the margin of a blackened disc of cardboard was cemented a silvered glass bead. This was set into rapid rotation in a dark room, and in close proximity to the flame in the glass tube. While the flame was silent, there was presented to the eye fixed upon the revolving bead a complete luminous circle, which, when the flame began its song, was broken up into detached beads of light. By increasing the velocity of the disc, these brilliant

points, or lumps, were reduced in number, and stretched into separated luminous arcs. The tube used was 3 feet long, and it was found possible to secure such a speed as to have only five luminous arcs. If the revolving mechanism be furnished with a counter or register, like the syren, we have here a simple and ready method of determining the number of vibrations per second of a sounding flame. For this purpose the bead should be light and the disc small. For lecture-room illustration the silvered ball should be large, so as to give a larger image of the flame and a more voluminous bright circle.

To illustrate the use of the method suggested above, let me cite the following measurements:—Employing a glass tube $3\frac{1}{2}$ feet long, with an average diameter of nearly $1\frac{1}{16}$ inches, and keeping the bead whirling so as to present five stationary luminous arcs, the first and second observations gave each 1576.8 rotations of the disc in 43 seconds. The third and last gave 2014.8 rotations in 56 seconds. Giving to each observation the same weight, we have 182.2 vibrations of the sonorous flame per second.

The syren, applied to the same problem, gave 177.7 vibrations per second; but it must be added that I found it impracticable to keep my syren exactly in unison with the flame at so low a note. Beats were heard during almost the entire period (90 seconds) of the experiment.

The note in question, compared with those of a set of excellent tuning forks made by Richie, of Boston, was nearly F.

Again, the luminous arcs were, as nearly as I could judge, about 48° each in extent. This being so, the light of the sounding flame endured conspicuously at each pulsation $0^{\circ}00366$, or $\frac{1}{271}$ of a second.

It was noticed, too, that each arc varied in brightness, the point of maximum illumination being, not at the centre of the arc, but beyond it; so that it would appear that in each luminous interval the flame lost its light more rapidly than it acquired it.

I have spoken of the luminous arcs as though they were absolutely detached from each other. So they appear to a careless observer. A close scrutiny, however, revealed an extremely faint and fading thread of bluish light uniting them. Hence, in this case at least, we cannot accept Dr. Tyndall's conjecture that there is an absolute extinction, periodically, of the singing flame.

I have applied the revolving silvered ball to the solution of the following problems:—

(1.) To adjust two sounding flames to exact unison, or to test the perfection of accord between two apparently unisonant flames.

The revolving ball presented to the two flames gives two intersecting circles of images, which, in case of exact unison, are equal in number, and present identically the same retrogradations, stations, and advances, during the variable motion of the ball.

(2.) To determine the exact, or the approximate value of the musical interval between two sounding flames. Adjusting the velocity of the ball so that each flame gives a circle of stationary images (luminous arcs), the relative number of these images will express the interval required. Thus, for one pair of flames, I found the interval to be 2 : 1; for another pair, 4 : 3.

If, when one set of images is stationary, the other set has a slow motion, the relative number of the images will give an approximate value of the interval, the direction of the motion with respect to that of the

* From a communication to J. D. Dana, dated University of Virginia, Feb. 29, 1868.

ball determining whether the value is too large or too small.

For these applications it is obviously unnecessary for the rotating mechanism to be furnished with a register. Indeed a kaleidophone might be used for the same purposes, though with some inconvenience. The silvered balls I have employed vary from half an inch to 2 inches in diameter.

It is scarcely necessary to apprise the readers of this journal, that the method herein set forth is a simple modification of an experiment devised and described by Prof. W. B. Rogers.*

In the progress of these experiments, it was often noticed that the luminous arcs, or stretched images, of the sonorous flame, were placed in echelon. The reason is manifest, when the silvered ball is revolved slowly and close to the flame. The separate images are then found to be inclined in the direction of revolution, their inclination augmenting with the velocity of the convex mirror, and the slope of the after edge of the image being steeper than that of the front edge. The same tilting of the images occurs, as is well known, in resolving the flame either by Wheatstone's or Tyn-dall's processes, when the mirror, plane or concave, is rapidly turned. I am not aware that the significance of this fact has attracted attention. Does it not indicate that the flame both recovers and loses its light progressively from base to summit, the loss being more rapid than the recovery, and that at no single instant of its history is the sounding flame such in size and form as it appears to be when steadily viewed? Moreover, if the flame, in any case, be rekindled from above, as it must be, if it is ever absolutely extinguished while sounding, it would seem that its image on its first edge at least should be tilted in a direction opposite to the motion of the mirror.

I shall conclude these notices by stating a fact bearing upon the theory of these flames. I have found no difficulty in causing the flame to sing when inserted quietly into a horizontal tube, carefully leveled. Tubes of various lengths and diameters were used. In narrow horizontal tubes, the vibrations are soon arrested by the accumulating products of combustion. In a tube $1\frac{1}{2}$ inches in diam. and 3 feet long, the flame sang for an indefinite time. While it was sounding, no drifting of smoke previously introduced into the tube, or of a column of smoke rising past its distant end, could be detected. It is easy to pass from the ordinary erect position of the tube and gas jet, through all grades of inclination to the inverted position of both, without cessation of the sound, and without disturbing the axial position of the flame.

If by maladroitness the flame is silenced at the critical attitude, it will be observed that the latter is below the horizontal position.—*Am. Journ. Sci.*, May, 1868.

ON THE

ACTION OF FERROCYANIDE OF POTASSIUM ON MONOCHLORACETIC ETHER.

BY O. LOEW,

Assistant in the Laboratory of the College of the City of New York.

KOLBE was the first to prepare cyanacetic acid, which is especially interesting from its transformation into

malonic acid by treatment with potassa. In a similar manner Heintz prepared sulphocyanacetic acid by boiling monochloracetic ether with sulphocyanide of potassium. This led me to try the action of ferrocyanide of potassium upon monochloracetic ether, to ascertain whether the radical ferrocyanogen can participate, as such, in the reaction. I boiled monochloracetic ether, dissolved in alcohol of 90 per cent, with powdered ferrocyanide of potassium for 4 to 6 hours. An action gradually took place, by which chloride of potassium was formed, together with another light blue amorphous substance, which became of darker colour on exposure to the air, and was undoubtedly Prussian blue.

When the liquid was filtered and boiled with caustic potassa, ammonia was developed; after the latter ceased to be evolved, the liquid was mixed with sulphuric acid and agitated with ether. On evaporating the ether I obtained white crystals, having the appearance of malonic acid. This substance was converted into the lead salt by precipitation with acetate of lead: 0.2997 grm. yielded 0.2904 grm. sulphate of lead = 66.99 per cent Pb. The malonate of lead contains 66.99 per cent Pb.

The reaction is therefore not analogous to that above cited, but the radical ferrocyanogen is broken up into cyanide of potassium and cyanide of iron. The former yields, with chloracetic ether, chloride of potassium and cyanacetic ether, while from the last named body malonic acid is produced.—*Am. Journ. Sci.*, May, 1868.

FOREIGN SCIENCE.

PARIS, JUNE 3, 1868.

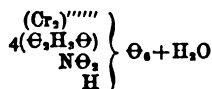
A plea for unapplied science—The congress at Sorbonne.—New acetate of chromium.

At a Congress of the Learned Societies, at Sorbonne, M. Nicklès delivered a lecture "On the new fluosalts and their uses." An account of the ferric fluosalts made by M. Nicklès has already appeared under the heading Foreign Science. He showed the disappearance of colour from the sulphocyanide of iron upon the addition of an alkaline fluoride, and numerous experiments of a similar kind, showing how the ordinary coloured precipitates of various metallic oxides were modified. Fluoride of potassium offers no impediment to the production of ferrocyanide of copper, but many polycyanides are decomposed. Platino-cyanide of magnesium is precipitated white, at the same time that it loses its dichroism; the beautiful blue crystals of manganocyanide of potassium are also destroyed by fluoride of potassium. After describing numerous coloured substances that were interfered with, M. Nicklès remarked—"What is the good of all these operations, having for their purpose the destruction of beautiful colours, will one ask? New facts are made known, errors are rectified, the history of a simple body becomes complete, but what matters this to those who cry *cui bono* where these products of human labor, where these conquests over nature are not immediately applicable to our physical wants. We might reply, that a new fact being acquired, no one can predict all the consequences which may result." M. Nicklès justified in eloquent terms purely scientific research, and alluded to the vast number of substances, largely employed in industrial operations, which had remained unused for great lengths of time, in the majority of cases, too, these substances having been first made only for scientific interest.

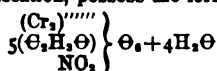
A paper "On a new acetate of chromium," has been published by M. Schützenberger. By mixing four or five equivalents of neutral acetate with one equivalent of neutral nitrate, and concentrating by heat, small green crystals

* *American Journal of Science*, vol. xxvi. p. 10.

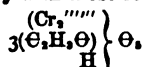
were obtained; this salt, dried at 110° , possessed the formula—



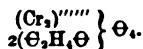
The salt is soluble in warm glacial acetic acid, the solution upon cooling yielding beautiful fern-like masses of crystals, which, after desiccation, possess the formula—



From these experiments chromium, like iron, is evidently capable of forming a series of salts of two acids. Interesting as this may be, M. Schützenberger has investigated the action of heat upon various acetonitrates, and the account of their behaviour when heated occupies the larger portion of the paper referred to. The final result and progressive states, induced by heat, are the same in all of these salts. Towards 200° water and acetic acid are disengaged; above this temperature nitrous vapours appear, at the same time the pulverulent residue assumes a deep yellowish brown tint. At this stage the compound is still soluble in water, and reagents detect the presence of chromic acid. Finally, at about 350° (in mercurial vapour) a brisk action is established, gas being disengaged, and the light powder thereby thrown into little conical heaps. In a few moments this stage is passed, and there remains a light powder of a clear green tint, pyrophoric while hot. The ultimate product contains no nitrogen; prepared with an acetonitrates purified several times by crystallisation, and heated by mercurial vapour in a current of carbonic acid to remove acid vapours and protect the heated residue from the atmosphere, the residue yielded upon analysis the following numbers:—Cr. 34.1, C 22.43, H 3.14, numbers agreeing pretty closely with those required by the formula—



which is that of a first, triacetochromic anhydride. In presence of water this powder hydrates immediately, with elevation of temperature, and becomes a homogeneous green paste. Dried, this paste shows a fine deep and peculiar green tint, possessing transparency. As more and more water is added, the paste becomes proportionately thinner, till at last a veritable solution is apparently produced. This solution is colloidal: the addition of a neutral salt of an alkali precipitates the whole of the acetate. The anhydrous powder, heated to about 400° , loses more acetic acid, while retaining the property of hydrating with water; probably there is formed a second anhydride, diacetochromic anhydride—



Finally, in the vapour of boiling sulphur the decomposition is complete, and there remains only the anhydrous oxide mixed with carbon.

PARIS, JUNE 10, 1868.

New polarising apparatus.—Testing colouring matters.—Ferric hydrate and ferric chloroxide.

A new polarising apparatus has been constructed by M. Hempel, from a suggestion by M. Plucker, the eminent physicist and mathematician of Bonn. The apparatus, which, in the majority of its parts, is similar to one already known, is made up as follows:—(1) a black glass, usually horizontal, but capable of being more or less inclined, and upon which the incident ray is polarised rectilinearly by reflection; (2) a disc or ring destined to carry and maintain, in the path of the reflected polarised ray, the transparent plate which is to exhibit chromatic polarisation; (3) a convex lens which renders the ray leaving the transparent

plate parallel or convergent; (4)—and this is the addition which gives to the instrument a perfection scarcely expected—a parallel glass silvered on the exterior surface, and fixed in a support at such an inclination that it leads to the vertical the doubly reflected and transmitted ray, which it directs to the Nicol's prism, serving as analyser.

Referring again to M. Nicklès' lecture "On the new fluo-salts and their uses," noticed last week, your correspondent finds some points of interest that ought not to be omitted. M. Nicklès showed how the various colouring matters used in industry might be detected. For example, commercial substances often owe their colour to "artificial blood;" knowing that sulphocyanides are poisonous, one might wish to be certain whether sulphocyanide of iron had been used in this case. A drop of fluoride of potassium discharges the colour from the iron compound immediately. Similarly, looking at a fabric dyed blue, one might wish to ascertain whether the colour belonged to the anilines, indigo or prussian blue; the two first being unacted upon by the test solution, the fabric would receive a drop of this solution, and then be subjected to a jet of steam. Iuka, of course, may be examined in the same way. Those having indigo-carmin for the base, become redder with the fluoride of potassium solution.

In a memoir presented a short time back to the Academy, M. Jeannel remarks "why certain varieties of hydrated sesquioxide of iron dissolve easily in acids, dissolve incompletely, or give unstable salts, is ignored; all that is known is that calcination is an absolute condition of insolubility." He then states that he believes to have found the cause, or at least the most frequent cause of these variations; the hydrated sesquioxide of iron is more or less insoluble in acids, and gives salts more or less unstable, when prepared from substances containing sulphates. Sesquioxide precipitated from the persulphate is always to a certain extent insoluble, or yields unstable salts; the same is the case with the sesquioxide precipitated from the perchloride, when this has been prepared with acids contaminated with sulphuric acid, or equally when the alkalies employed as precipitants have been so contaminated, or, finally, when the ferric hydrate precipitated from pure solutions by pure alkalies has been washed with common water, which chemists need not to be told, nearly always contains a little earthy sulphate. Ferric hydrate prepared from materials rigorously free from sulphates, and in vessels rinsed with distilled water, is extremely soluble in the cold in very dilute acids: notably, it dissolves with surprising facility in the official solution of perchloride of iron. A new compound, indefinitely soluble, which might be named ferric chloroxide, is easily obtained in solution or in the solid state. This compound is represented by the perchloride of iron, Fe_2Cl_6 , and an indeterminate quantity of sesquioxide of iron, Fe_2O_3 . M. Jeannel has prepared, in the cold, a stable aqueous solution of ferric chloroxide, which may be represented by the formula $\text{Fe}_2\text{Cl}_6, 9\text{Fe}_2\text{O}_3$, and consequently contains nine times as much iron as the neutral or official solution. This solution of ferric chloroxide might perhaps be found specially advantageous in checking hæmorrhage. The solution possesses in the highest degree the property of coagulating albumen, and removing albuminoid and colouring matters. A few drops thrown into water produce a very voluminous brown precipitate. The solution of ferric chloroxide is decomposed and precipitated by very small quantities of sulphuric acid, or of sulphates, soluble or insoluble. It is likewise decomposed by citric, or tartaric acid, and curiously, or rather surprisingly, it is decomposed by a few drops of concentrated hydrochloric or nitric acids.

PARIS, JUNE 17, 1868.

Estimation of phosphoric acid.—Oxidation of alcohol.—Aniline black varnish.—Treatment of beet-root pulp.—Extraction of sugar from beet-root juice and molasses of all descriptions.

REFERENCE has already been made to M. Schlessing's pro-

cess of determining phosphoric acid; the following is the manner in which the experiment is made:—A tube of green glass is fashioned before the blowpipe, so that there is first a part (A) of 30 centimetres in length, which rests horizontally upon wire gauze, and where the reactions take place; then a part drawn out of about 15 centimetres in length, inclined downwards and backwards, after which the tube is continued horizontally, and with the original diameter, for the length of 10 centimetres. Thus there is formed a kind of bulb (B), terminated by a recurved point, destined to condense the chloride of phosphorus. At the end of the part A, a tuft of asbestos is placed, and upon this pure chloride of potassium, decrepitated and coarsely powdered: this chloride occupies from 12 to 15 centimetres, and is maintained in its place by another very small tuft of asbestos. Afterwards the porcelain boat, containing the phosphide in fragments, with a last tuft of asbestos, is introduced. Finally, the end of the tube is closed by a cork carrying a little piece of tube. In the bulb, B, a little water is placed, and a vertical tube containing fragments of moistened porcelain is attached, where phosphoric vapours not condensed in B will be condensed. After this arrangement comes a little washing flask, serving to show the current of chlorine. After having heated the chloride of potassium, and driven every trace of moisture out of A, by a current of dry air, the chlorine is admitted; but the porcelain boat is not heated till the tube has been swept through with dry air. As soon as the reaction commences, a red liquid is condensed round the boat, and spreads over the chloride of potassium. This chloride ought to be heated, but only near the boat, to a sufficiently high temperature to melt the double chloride, otherwise the tube will become closed up. Towards the end of the operation the heat is raised a little, without at the same time allowing it to reach dull redness, for at this degree of heat the phosphorus exchanges its chlorine for the oxygen of the silica of the glass, and forms phosphates. The perchloride of phosphorus is condensed at the end of the tube A; by application of a gentle heat it is chased into the bulb. The experiment is finished when the least trace of condensation is no longer observed. A constant but feeble excess of chlorine should be maintained throughout, and the operator requires to have the chlorine easily at command; for this, the arrangement with a couple of tubulated flasks and pinchcocks is convenient.

To determine the phosphoric acid condensed in the bulb with hydrochloric acid the glass is cut in the narrowed part, the liquid transferred to a porcelain dish, and the washings of the bulb and the tube with porcelain united, nitric acid added, and the whole evaporated. The hydrochloric acid, decomposed towards the end of the operation, is eliminated without loss. All that is now required is to estimate free phosphoric acid in the presence of nitric acid, and for this purpose M. Schloesing employs nitrate of silver.

It has been frequently remarked by vinegar makers that the acetification of alcohol in the casks does not proceed regularly, and that the corresponding strength of acid is not obtained. To facilitate oxidation, M. Artus dissolves 15 grammes of dry chloride of platinum in 25 kilogrammes of alcohol, and in the solution places 1.5 kilogramme of pieces of wood charcoal in pieces of the size of a nut; he then calcines in a covered crucible. This done, he takes 0.75 kil. of platinised carbon, and strews it upon a wooden cover pierced with holes, placed over the open top of a vinegar cask, 2 metres in height and of from 0 m. 80 to 0 m. 90 in diameter; the vinegar is not allowed to moisten directly the cover with the platinised carbon. After five weeks' work, the platinised carbon is calcined afresh. The action of this carbon is very remarkable, the acetification is effected more rapidly and completely than in operating in the ordinary way, and the vinegar possesses a more agreeable flavour.

An aniline black varnish, of recent Parisian production, is the following:—In a litre of alcohol 12 grammes of aniline blue, 3 grammes of fuchsine, and 8 grammes of naphthaline yellow, are dissolved. The whole is dissolved

by agitation in less than twelve hours. One application renders a white object ebony black; the varnish can be filtered, and will never deposit afterwards. The three colours are not destroyed, for each can be separated by analysis with the characteristic properties.

A modification in the treatment of beet-root pulp has been introduced by M. Champonnois. The experiments relative to the process were made in the laboratory of MM. Périer and Persoz, and subsequently repeated in the laboratory of the *Conservatoire des Arts et Métiers*. The quantity of beet-root operated upon in each case was two kilogrammes. This amount was grated, 30 per cent of water added, and the pulp pressed in the usual way. The juice was filtered through paper, concentrated, with addition of 1 per cent of fine animal black, purification which is considered equivalent to an ordinary filtration, working with coarser material. This syrup was concentrated to 22° Beaumé, filtered, and heated to 115° C., then left on a stove during five or six days; the crystallised mass was then freed from mother liquor. For the second, and for all following operations, this drained syrup, or molasses, was diluted with about 60 per cent of water for the weight of beet-root; this solution heated on the water-bath, and mixed with the pulp of 2 kilogrammes of beet-root, was maintained from ten to fifteen minutes at a temperature of 70° to 80°. The mass was then treated precisely as in the former case. The smallest particles of syrup adhering to the vessel crystallise completely and in large crystals. In the regular process of manufacture, the syrup removes about double the amount of albumen and salts, retained by the pulp; all these things are separated in purification, or remain in the molasses, and are consequently lost as alimentary matters. The pulps obtained in the new process, on the contrary, retain all these matters, and are much smaller in weight than the ordinary pulps; they can then, being returned to the farm, yield valuable materials, particularly the salts, which are rapidly removed from the soils upon which beet-root is cultivated; even this is the case when the quantity of ordinary pulp proportional to the beet-root which the matters in the soil have produced, is restored to the soil, for this proportion corresponds only to one-third, at the most, of the useful principles contained in the beet-root. By the continued recharging of the syrups, the work relating to bye-products is suppressed, work which requires a large outlay in cisterns and very large refineries. The only inconvenience that is met in the process advocated, resides in the proportion of water, which is double that commonly employed; but the increase in expense is alone due to carbon, and amounts to 1 franc more for 1,000 kilogrammes of beet-root; it is true that the apparatus destined to contain the juice is required to be somewhat larger. These facts are insignificant in comparison with the advantages of the new method, considered both in regard to the farm and the factory.

Appropos of the beet-root manufacture, M. Leplay's method of extracting sugar from juice as well as syrups and molasses of all descriptions, may be here referred to. M. Leplay sought to extract the sugar from the matters in question, by transforming it into insoluble sucrate of lime, which has not yet been made on an industrial scale. This combination is effected in the saccharine fluids treated, less by an addition of ready formed free lime, than by the aid of solutions of calcareous salts, and particularly of chloride of calcium, and of caustic soda, which precipitates the lime, and this combines and is precipitated with the sugar. The sucate of lime, after precipitation, is decomposed by means of carbonic acid, the soda in the solution regenerated, and the carbonic acid obtained as a secondary product in the formation of the chloride of calcium. A few additional statements of the author will render the precise nature of the process more evident.

When a solution of sugar in water is saturated with all the lime which it is capable of absorbing, and boiled, there is formed a white precipitate of sucate of lime, which is redissolved on cooling. The quantity of sugar thus elimina-

ted is only a small proportion of that present, and the greater part remains in solution when the precipitate is separated from the liquid during ebullition. Feebler still is the proportion of sugar that can be extracted from beet-root juice or molasses, and the more impure the saccharine fluid is, the less considerable is the separation obtained by this means. On the contrary, the whole of the sugar may be precipitated in the state of sucrate of lime, when in the solution already saturated with lime, a fresh quantity of lime is separated in the nascent state, then the precipitation is independent of the degree of purity of the saccharine solutions. Besides the juice of the beet-root, the molasses of sugar refineries are capable of treatment by the process. The quantity of soluble salts of lime present in the syrups, &c., exerts an influence on the proportion of calcareous salt which should be added; as these salts contain organic acids, the soda is no longer found in corresponding quantity, as chloride of sodium, but as carbonate of soda in the ash obtained from the mother liquor,—an important advantage. The previous saturation of the liquor submitted to treatment by pure lime, before the addition of the calcareous salt, is then essential, since by this means a portion of the calcareous salt which would be otherwise required, is replaced by the cheaper material, lime. The sucrate of lime precipitated is separated from the liquor, washed with water, and decomposed by carbonic acid.

REPORTS OF SOCIETIES.

ROYAL INSTITUTION OF GREAT BRITAIN.

Weekly Evening Meeting, Friday, April 24, 1863.

On Some New Experiments on Light, by J. H. GLADSTONE, Ph.D., F.R.S.

THE speaker commenced by referring to the fact that we are constantly making new experiments or observations on light: in fact, all seeing is but a comparison of different degrees of light and shade, and the contrast of colours. Most of the rays that meet our eyes from surrounding objects are reflected rays, but some of the commonest things, such as the water-bottles and tumblers of cut-glass on our dining-tables, exhibit beautifully the blending, the magnifying, the diminishing, and the production of coloured fringes, due to refraction. The purpose of this discourse was to rise from the simplest phenomena of this kind to a consideration of refraction-equivalents, and to describe the state of our present knowledge in regard to them.

By means of the electric lamp it was shown that a piece of glass, or other transparent body, will throw a perfectly black shadow if the two surfaces through which the ray passes be not parallel; that the light is then bent on one side, and at the same time spread out into its component colours; that this bending (refraction) varies with the amount of inclination of the two surfaces to one another, but in such a way that the sine of the angle of refraction bears a constant ratio to the sine of the angle of incidence; that this constant number, termed the index of refraction, or μ , belongs only to the one substance, each solid liquid, or gas, having its own index; that there is no necessary connection between the amount of refraction and the length of the spectrum (dispersion) caused by different substances, whether gaseous, liquid, or solid—for instance, a solution of an iodide always disperses more than a solution of the chloride of the same metal, even though it be diluted to the same amount of refraction.

This index of refraction is affected by change of temperature. In liquids, and probably in all gases, the bending decreases as the thermometer rises; in solids, on the contrary, as lately shown by Fizeau, the change is in the opposite direction, crown glass always remaining the same, and fluor spar being the only case where he observed a diminution. This was experimentally demonstrated in

regard to liquids. Thus a yellow sodium ray, which had passed through a hollow prism filled with oil of nutmeg, and thence through another filled with bisulphide of carbon, moved some inches along the screen, when the nutmeg oil was warmed a few degrees by stirring it with heated iron wire. This index of refraction is still more materially affected when a body passes from the solid to the liquid, or from the liquid to the gaseous condition; a fact that was illustrated by the visibility of the water melted in crystalline spaces in the middle of a block of ice.

The index of refraction of a mixture is moreover not always the mean of the indices of its constituents. Thus a ray passed successively through two hollow prisms filled with equal quantities of alcohol and water respectively, fell on the screen in a certain position; but when the two liquids were mixed together, and divided between the two prisms, the ray was visibly refracted to a greater distance.

These changes depend on the alterations of volume which the substances undergo; and the speaker, in conjunction with the Rev. T. Pelham Dale, had observed in liquids that the index of refraction, minus unity, divided by

the density (in symbolic language $\frac{\mu-1}{d}$) is constant for all

temperatures, and for all mixtures, or rather that the coincidence is very close, but not quite perfect on account of some other law not yet understood. This conclusion has been abundantly verified by Landolt of Bonn, Ketteler, and Wullner, and the former experimenter has founded upon it a method of analysing mixtures of liquids.

This unchangeable number was termed the "specific refractive energy" of the substance, and it seemed to hold good notwithstanding a change from the solid to the liquid or the gaseous condition. It was early observed that the specific refractive energy of a compound bore a close resemblance to the mean of the specific refractive energies of its components. Landolt, by multiplying this number by the chemical equivalent, facilitated the calculation greatly. He termed this new number the "refraction-

equivalent," $P = \frac{\mu-1}{d}$, and proofs have rapidly accumulated -

that the number is little affected, not only by temperature, change of aggregate condition, mixture, or solution, but even by strong chemical combination.

Thus diamond, which is crystallized carbon, has the refraction-equivalent 5.0; sulphur has 16.0. Bisulphide of carbon, CS_2 , which is nearly the most refractive liquid known, should therefore be represented by $5 + 2 \times 16$, that is 37.0. The experimental number is 37.3. But the diamond will burn in oxygen, and is thus converted into carbonic anhydride, while it is possible to reduce this gas into another containing only half the amount of oxygen, namely, carbonic oxide. The refraction-equivalents of these gases, as deduced from Dulong's observations, are respectively 10.03 and 7.53; but the difference between CO_2 and CO is one equivalent of oxygen, and the difference between the above numbers is 2.5. This then may be taken as the refraction-equivalent of oxygen, and subtracting it from $CO = 7.53$ we have remaining $C = 5.03$, practically the same number as that obtained directly from crystallized carbon. Similarly, but generally by more indirect methods, it has been determined that this element, whether pure as diamond or combined with other elements to form gases as the above-mentioned, coal-gas, or cyanogen, or liquids as chloride of carbon, benzol, oil of turpentine, alcohol, or ether, or solids as paraffin, sugar, or camphor, is still exerting the same influence on the rays of light that set its particles in motion, an influence that we can express by the number 5.0. Again, to revert to sulphur, the two salts sulpho-cyanide and cyanide of potassium— $KSCy$ and KCy —differ by one equivalent of this element, and their refraction-equivalents as determined from their aqueous

solutions are respectively 33.4 and 17.1, numbers differing by 16.3, a number almost identical with that reckoned from molten sulphur. In this way the refraction-equivalents of a large number of the elements have been determined; and the following table comprises what seem the most probable numbers among those that have been hitherto published by Landolt, Haagen, and Schrauf, as well as the speaker:—

	Atomic Weight.	Refraction Equivalent.
Hydrogen	1.0	1.3
Chlorine	35.5	9.8
Bromine	80.0	15.7
Iodine	127.0	24.4
Oxygen	16.0	3.0
Sulphur	32.0	16.0
Carbon	12.0	5.0
Silicium	28.0	6.2
Nitrogen	14.0	4.1
Phosphorus	31.0	18.5
Arsenic	75.0	16.0
Antimony	122.0	25.7
Vanadium	51.4	25.4
Sodium	23.0	4.9
Tin	118.0	19.2
Copper	63.4	11.2
Mercury	200.0	21.6

The above numbers are reckoned for the red ray. Most of them as yet claim to be considered only as approximate; and it seems certain that some elements, as oxygen and sulphur, have more than one refraction-equivalent.

Vanadium, though included in the above table, has only just been determined, and that from the oxytrichloride which Professor Roscoe exhibited a few weeks before. It is interesting, as it supports his theory of the close analogy of phosphorus and vanadium, for these two bodies, with sulphur, exceed all others in refraction and especially in dispersion.

The speaker stated that he was now engaged in examining the effect of salts in solution on the rays of light, and that he hoped to determine in this way the refraction-equivalents not only of a multitude of salts, but of the metallic elements themselves.

But the question may be asked, "If a substance has a refraction compounded of the refraction of its constituents, how can bodies such as Iceland spar have two refractive indices?" Now these are crystalline bodies, or if uncrystallized they have become doubly refracting by being unequally heated or compressed. In either case we may suppose a different amount of tension in different directions; and the fact of the two rays being oppositely polarised points to some such difference of molecular arrangement. It is easy to understand that the change of tension or internal structure may act in the same way as a change of density in modifying the velocity of transmitted light, and therefore the amount of its refraction. But if we take the crystal to pieces by dissolving it, there can then no longer be unequal tension or unsymmetrical arrangement of particles, and it must have one refraction-equivalent. And this is always the case. The numbers deduced from Brewster's observations of the two rays of crystallized nitre are 16.3 and 25.0, while the equivalent of nitre dissolved in water is the intermediate number 21.8.

ACADEMY OF SCIENCES.

PARIS, MAY 11, 1868.

Manufacture of phosphate and fluoride of sodium.—New process of refining sugar.—Vegetable fibres employed in industry.—18th of May: Award of the long-deferred prizes.

THE following memoirs were brought before the Academy at the meeting held on the 11th of May:—"Analysis of a

chromiferous pig iron," by M. Boussingault (translated in full); "on a new process of refining coarse sugars and molasses, yielding colourless and pure sugar, without the employment of animal black or albuminous substances," by M. Woestyn; "vegetable filaments employed in industry, characters permitting of distinguishing between them," M. Jean addressed a rectification to his note on the manufacture of phosphate and fluoride of sodium; M. Zaliwski-Mikorski made a communication relative to the weight of the air.

The process of sugar-refining made known in M. Woestyn's memoir is simple. The sugars being dissolved to a certain degree Beaumé, varying according to the practice of the refinery, milk of lime is introduced, the amount added for fine coloured sugars being reckoned by thousands, progressing to hundredths for the yellow tints. After having intimately mixed the lime and the syrup, a current of carbonic acid is made to pass into the mixture, until test paper shows no trace of alkalinity. M. Woestyn operates at from 20° to 30° C. The operation is terminated by ebullition, to decompose the bicarbonates, and the deposit is separated by filtration, sometimes decantation may be substituted. The resulting syrup is deprived of colour, and yields sugar of great fineness, both in regard to taste and brilliancy.

M. Vétillard's memoir was a very minute description of the microscopical characters, when treated by reagents, and in some cases dissected, of linseed, hemp, jute, New Zealand flax, China grass, and cotton fibres.

M. Jean informed the Academy that by an error in calculation, he had come to the conclusion that in fusing tribasic phosphate of lime with an excess of sulphate of soda and carbon, nearly the whole of the phosphoric acid was obtained in the state of neutral phosphate. Recent experiments have proved to him, that under these conditions, the phosphate of lime only cedes two-thirds of the phosphoric acid in the soluble state.

At the meeting held on the 18th, M. Chevreul presided, and the prizes in various branches of sciences were awarded to the candidates of 1867. The prize subjects ranged through many sciences, physiology, medicine, astronomy, mathematics, chemistry, &c. The works worthy of a prize in connection with noxious trades (founded by M. De Montyon) were considered by MM. Combes, Dumas, Payen, Balard, and Chevreul, reporter. The report states that long since the law of 1810 has shown itself insufficient, notwithstanding various modifications made, indeed for twenty years the necessity has been felt of placing the class of manufactures referred to in this law more in harmony with the progress of science, in the double interest of health and the manufactures themselves. The law of 1810 was created especially to prevent the dangers of acid vapours such as arise in the roasting of pyrites and the hydrochloric acid of the alkali factories recently established. Doubtless at this epoch there existed many works operating upon organic matters, and the inconvenience they caused was known; but these works were then restricted in number, and confined to localities where from their long existence, the inconveniences to the neighbourhood were tolerated. It was then in the double cause of the public health and the progress of industry that the administration of agriculture, commerce, and works, directed the consulting committee of arts and manufactures to revise the law of 1810. The committee deemed it desirable that they should possess a knowledge of the state of the factories and works in the foreign countries most advanced in point of industry, and to this end, M. de Freycinet, a mining engineer, was commissioned to visit England. The subject of the questions proposed to M. de Freycinet were—(1.) The examination of factories or works considered dangerous or inconvenient from three points of view: the pollution of the atmosphere, the pollution of water, and the influence of the process upon the workmen. (2.) The indication of the means, or processes of abatement em-

ployed in each noxious manufacture. M. de Freycinet's mission resulted in a report of 118 pages.

Finally, in 1866, M. de Freycinet visited England again by authority, this time to examine the employment of the sewage water of London. The first report was deemed so valuable that M. de Freycinet was charged to make a similar work for France; this matter was embodied in a report of 247 pages. The prize commission recognizing the value of his services, proposed to award to M. de Freycinet 2,500 francs. The proposition received the approbation of the Academy.

The chemical section unanimously voted the Jecker prize to M. Berthelot for his late researches on the carbides of hydrogen.

PARIS, MAY 21st, 1868.

New substance replacing magnesia in the oxyhydrogen light.—Estimation of phosphates by conversion into phosphides.

THE following memoirs of chemical interest were communicated to the Academy on the 21st:—"On the composition of the gaseous mixture used in the oxyhydrogen light, and on a new matter replacing magnesia," by M. Caron; "Estimation of phosphoric acid by the transformation of the phosphates into phosphides of iron," by M. Schlösing; "Researches on the combustion of oil," by M. Scheurer-Kestner; "Researches on the bleaching of tissues," by M. Kolb; "On the dilation of solid bodies by heat," by M. Fizeau.

The magnesia pencils, made either by compression or by the wet method, cannot, M. Caron says, resist indefinitely the intense heat produced by the combustion of coal-gas mixed with oxygen. It would likewise be difficult to use magnesia with pure hydrogen and oxygen, which give rise to a more intense heat, and consequently greater corrosion. Therefore, he examined other substances. Knowing the infusibility of silicate of zirconium, M. Caron tried this material, but found the light emitted by the pulverised and agglomerated zircon very small, the case with most silicates. There remained the earth zirconia yet. According to Berzelius, this earth is infusible, and emits a brilliant bluish light in the blow-pipe flame. This M. Caron has tried, and to him the earth does not seem volatile in the oxyhydrogen flame. The same pencil used daily for more than a month, heated upon a sharp angle, shows no trace of volatilisation, partial reduction, or loss of any kind. This fact is important, for with a lamp burning only a feeble jet of gas, the part of the flame which gives the light is very small, and the incandescent matter must of necessity always remain at the same distance from the point; as the pencil becomes used, this distance augments, and the light diminishes more and more. M. Caron says, the employment of zirconia seems to him to lead to a notable improvement in the oxyhydrogen light, for besides the valuable quality of remaining intact, zirconia possesses luminous properties even greater than those of magnesia, the proportion being nearly as 6 : 5. Zirconia, it is true, is infinitely rarer than magnesia, but it is found in many volcanic sands, and especially in great abundance in the zirconic rocks, near Miask in the vicinity of Ilmenec, at the foot of the Ural. This rare earth, too, can be easily economised; it need only be employed where the flame impinges, the remainder being magnesia or refractory clay; compression will fasten the two materials together, and baking add to the solidity of the pencils.

M. Schlösing's memoir deserves a somewhat detailed account. This chemist described in 1864 a process for estimating phosphoric acid, based upon the reduction by carbonic oxide, at a high temperature, of phosphates placed in contact with silica; the phosphorus was collected upon copper, or in a solution of nitrate of silver. When the phosphates contain oxide of iron, this process ceases to give exact results. Obligated to accept its presence in manures, vegetable ashes, &c., M. Schlösing decided to make

the iron perform a part in a process. Alkaline and earthy phosphates heated to whiteness in a carbon crucible, with silica and iron, cede to the metal the whole of their phosphorus. This transformation being effected, the phosphorus requires only to be separated from its combination with iron. The task is not as easy as it at first sight appears to be. Acids are not admissible. When dry chlorine passes at a moderately elevated temperature over iron containing phosphorus and some other metalloids, arsenic, sulphur, and silicium, all the bodies are converted into chlorides; this fact is well known. The chloride of iron is less volatile than the others, but not sufficiently so to permit of accurate separation; with the phosphorus, the difficulty is augmented by the formation of a combination between its chloride and the chloride of iron. M. Schlösing has been enabled to destroy this combination by the use of chloride of potassium, which at the same time greatly lessens the volatility of the chloride of iron. At the temperature at which the experiment is made, the whole of the chloride of phosphorus is disengaged absolutely free from the metallic chloride. The process is minutely described; it will be given in my next letter. Experiments showing the accuracy of the process are appended; in the following figures, the first in each case represents the number required by theory, the second that found—43.74 mg. 45.70; 47.9 mg. 47.5; 3.32 mg. 3.50. Results which testify to the value of the process.

PARIS, 1868.

Combustion of oil.—Chemical harmonica.

M. SCHEURER-KESTNER, in his memoir "On the combustion of oil," presented to the Academy, states that his researches are divided into three parts: (1) chemical study of the gas resulting from the combustion of oil, estimation of the combustible gases, and of the lampblack; (2) calorimetric studies, heat from the combustion of oil, relation between the chemical composition and the caloric power; (3) calculations and practical results, study of the distribution of caloric in the heating of steam generators. The lampblack was estimated by causing a certain volume, 50 or 100 litres, of the gaseous products of combustion to pass through a glass tube filled with asbestos, which retains this carbon completely. The tube was afterwards heated to redness, a current of oxygen passed through, and the carbonic acid formed collected in potash. It results from the analysis of the gas, that when the supply of air is insufficient, that is to say, when the gaseous products only contain six to ten per cent of air in excess, the loss of carbon in the state of combustible gas represents about 20 per cent of the carbon of the oil consumed, and that this loss diminishes considerably when the burnt gases contain 20 to 50 per cent of air in excess, becoming then reduced to 4 or 5 per cent. The loss of hydrogen is more considerable: it oscillates between 10 and 20 per cent of the hydrogen contained in the oil, and depends less on the supply of air. In fact, the disengagement of hydrogen takes place by distillation. The presence of acetylene, as well as of other hydrocarbons, has been proved. Many tables of analyses occur in the memoir. The oil experimented with, was that of Ronchamp.

The following occur among the conclusions to a note "On the chemical harmonica," by M. Terquem. Relatively to the form of the flame, three cases may present themselves:—(1.) If the flame be long enough, and the current of air of little intensity, the vibratory motion does not reach the base of the flame; examined by the turning mirror, the reflected image presents the appearance of a continuous sinusoidal curve. (2.) If the current of air, and consequently the vibratory motion, be more intense, the flame vibrates in its whole length, and can even become completely extinguished; in this case, with the turning mirror, the images of the flame are quite distinct, the gas re-lights itself by reason of the high temperature reigning at the point. (3.) If the vibratory motion become still more intense, there is observed in the disengage-

ment tube a little reversed flame, which, seen in the turning mirror, alternates with the external flame; this almost exceptional phenomenon was the point of departure in the theory proposed by Schröter.

CHEMICAL SOCIETY.

Thursday, June 4.

DR. WARREN DE LA RUE, F.R.S., &c., *President, in the Chair.*

THE minutes of the previous meeting were read and confirmed, and the donations to the library announced. Messrs. G. W. Brown and James Richards were formally admitted Fellows of the Society; and the following gentlemen were balloted for and duly elected, viz.:—Henry Chance, M.A., glass manufacturer, Oldbury, near Birmingham; William Hustler, mining engineer, Rosemerry, Falmouth; and William B. Miller, assayer, Royal Mint, Sydney.

There were no new candidates proposed. For the second time were read the names of the following gentlemen, viz.:—Samuel Alexander Sadler (at Messrs. Chance's Chemical Works), Oldbury, near Birmingham, and H. B. Riddell (late of the Indian Civil Service), 9 Stratton street, Piccadilly.

Mr. E. T. CHAPMAN gave a short account of the reactions more fully described in three papers presented to the Society, of which Mr. Miles H. Smith and himself were joint authors.

I. "*Action of Chloride of Zinc on the Oxalic Ethers.*" Having sketched the chemical changes which were possible under these circumstances, the authors show that the action of the metallic dehydrating agent upon the oxalates of ethyl, amyl, and methyl, results in the formation of oxalate of zinc (left as a residue in the retort), but instead of obtaining the chlorides of these radicals as the direct result of a double decomposition, they are split up into hydrochloric acid and the olefines, or a mixture of bodies of the latter class; only in the last-named instance was a small quantity of chloride of methyl produced.

II. "*On the Artificial Production of Pyrrolone.*" Referring to Mr. Perkin's researches on this subject, and to a previous speculation as to the possibility of inducing the formation of artificial pyridine (*Chem. Soc. Jour.*, August, 1866), the authors now show that this body may be produced in small quantity by the action of anhydrous phosphoric acid upon the nitrate of amyl. The principal product of the reaction is a dark brown pitch-like substance, but a sufficient amount of pyridine was obtained upon distilling with potash, to permit of its identification, and of an analysis being made of its chloride, $C_5H_5N.HCl$.

III. "*Isomerism in the Organic Cyanides.*" On a review of Dr. A. W. Hoffmann's researches on the isomeric cyanides, it appeared to the authors desirable to attempt the formation, and study the characters of compounds produced by the action of dehydrating agents, such as anhydrous phosphoric acid, and fused chloride of zinc, upon the formamides obtained by acting with formic ether upon ammonia, ethylamine, aniline, and other amines. The products of these reactions were the so-called pseudo-cyanides, and were at once recognised by their peculiar odour, and by the decompositions they underwent upon treatment with acids. This method of proceeding cannot be considered available for the preparation of these cyanides in large quantity, and an attempt to obtain analogous bodies from the compound acetamides did not prove successful.

Dr. B. H. PAUL then gave an account of "*The Modes of Testing Mineral Oils used in Lamps,*" in which he showed that the results obtained as indicating the degree of inflammability of this oil were subject to considerable variation according to the mode in which the test was applied. It was also shown that there was a difference of opinion as to what should be regarded as the firing point, whether it was to be the temporary firing of the first small portion of oil vapour given off, or the permanent firing of the oil itself.

Between these two results there might be a difference of from ten to twenty degrees Fahrenheit, according as the oil was tested in a shallow open basin, or a partially closed vessel. In reference to the influence of the degree of inflammability of mineral lamp oil on the possibility of accidents occurring in the use of this material, it was shown that the mere volatility of the oil was not the only point to be considered, and that, apart from misuse and carelessness, the construction of the lamps in which it was burnt was of considerable importance. To illustrate this, a lamp filled with what is commonly known as spirit or naphtha (the most volatile portion of petroleum or paraffin oil), was kept burning during the meeting. This lamp was so constructed that there was no communication between the flame and the oil reservoir, except through the tube containing the wick, and consequently there was no chance of oil vapour or an explosive mixture of it with air coming in contact with the flame, so as to cause accident. Other kinds of lamps in which there is free communication between the oil reservoir and the flame, afford less security, especially when the oil used in them vaporises at a low temperature.

The mode of testing oil, and the possible variation of the results obtained under different conditions, were illustrated by experiments; and an apparatus devised by Mr. Rippin-gille, of the Albion Lamp Company, was shown. It consisted of a small copper vessel like a paraffin oil lamp fitted with a thermometer, and a valve, and two wires, by which an electric spark could be produced inside the vessel. By gradually heating the oil to be tested in this vessel, and passing the spark from time to time while the temperature was observed, a point was at length reached when there was a slight explosion, and this was taken as the firing point of the oil.

In conclusion, the author pointed out that whatever degree of inflammability was fixed upon as the proper minimum for safety, the mode of testing should be precisely defused, and the experiment should always be made under like conditions.

A short discussion followed, in which Messrs. Dugald Campbell, E. T. Chapman, and Dr. Attfield took part. The general conclusion arrived at was that the danger from explosion had been greatly exaggerated, and that when such events occurred they might sometimes be traced to faults of construction in the lamp. It was generally agreed that an oil which does not give off inflammable vapour below 100° Fahr., should be accounted safe, but no precise figure below this point on the thermometric scale was adopted at the meeting, although Mr. Dugald Campbell, amongst other speakers, pressed for a decision to support his own judgment in the matter.

The PRESIDENT, in moving a vote of thanks to Dr. Paul, took occasion to support his view of the case, namely that the construction of the lamp was as important as the firing point of the petroleum, and that the dangers of explosion had been greatly overrated.

The meeting was then adjourned until Thursday, the 18th instant, which will be the last during the present session.

Thursday, June 18.

DR. WARREN DE LA RUE, F.R.S., &c., *President, in the Chair.*

THE minutes of the previous meeting were read and confirmed, and several donations to the library acknowledged. Mr. Wm. Hustler, of Falmouth, was formally admitted a Fellow of the Society, and Messrs. H. B. Riddell and S. Alexander Sadler were duly elected. The following gentleman was proposed for election:—W. J. Palmer, M.D., F.R.C.S., Surgeon Bombay Army, and Additional Chemical Examiner to the Government of India.

The PRESIDENT reported the steps taken towards providing superior accommodation for the Society in the new buildings at Burlington House; this statement was well-timed, and

appeared necessary in consequence of the front wall in Piccadilly having been parcelled out for sale by public auction. It is understood, however, that the Italian colonnade will be preserved by special order of the First Commissioner of Her Majesty's Works.

Dr. J. H. GLADSTONE made a statement by way of post-script to his recent paper "On the Tetraphosphoric Amides." When nitrate of silver was added to tetraphosphopentazotic acid, $P_4N_4H_5O_7$, some hydrogen and nitrogen disappeared, and a difficultly soluble salt was formed, containing:—

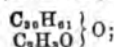


If the acid corresponding to this, viz.:— $P_4N_4H_5O_7$, be taken from the constituents of two atoms of the above pentazotic acid, there remain the elements of another compound, $P_4N_4H_{12}O_7$, which forms with silver a soluble salt. A special experiment, undertaken for the purpose of elucidating this point, gave 151 instead of 162 parts of silver salt from 100 parts of the first-named acid, a result close enough to warrant the assertion put forward by the author in explaining these somewhat complicated changes.

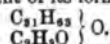
Professor J. A. WANKLYN read a paper "On High Chemical Formulae—the ground on which they rest: Examples, Mellissic Alcohol, Cerotic Acid, &c." The author insists upon the importance of establishing the composition of organic bodies of high formulae, not only by reference to the method of ultimate analysis, but by studying a wide range of chemical reactions and decompositions. The highest members of the fatty series were selected for criticism by Mr. Wanklyn, who showed that Sir Benjamin Brodie's analyses of mellissic alcohol, published in 1848, led not only to the formula adopted, $C_{28}H_{52}O$, but would stand good for all compounds lying between the terms $C_{28}H_{52}O$ and $C_{27}H_{50}O$, which contain 81.95 and 82.84 per cent of carbon respectively. The theoretical number for the adopted formula being 82.19, and Sir B. Brodie's results ranging, for carbon, from 82.01 to 82.77 per cent. Hydrogen stands within even closer limits of variation, differing only by 0.03 per cent in the two extreme compounds already named. The same remarks were applied to mellissic acid and its silver salt; the analysis of the latter was said to agree equally well with formulae differing from each other by CH_2 , thus:—

C_{28} requires carbon	63.85	C_{28}	64.38
H_{52}		H_{52}	
Ag	19.89	Ag	19.30
O_7		O_7	

The author concludes by a recommendation to employ the method of titration of the ether, converting the mellissic alcohol, for instance, into a suitable ether, then liberating the acid, and determining it as a baryta salt. 100 parts of acetate of mellissyl treated in this manner should yield 26.56 parts of acetate of baryta, if its composition be



or 25.81 parts, in the event of its formula being



Professor Wanklyn referred to Berthelot's researches on glycerin as illustrating the advantage of pursuing this line of investigation.

The PRESIDENT said he had a clear recollection of the first appearance of Sir Benjamin Brodie's paper on Chinese wax, which was at the time considered to be one of the most masterly treatises in the then comparatively new department of organic chemistry. He could not help regretting that Professor Wanklyn had applied the criticism of modern science to an investigation published twenty years ago, for it should be remembered that the progress of chemistry had made great strides during this interval. Chemists generally were aware that it is difficult to fix the rational formula of a body from the evidence afforded by combustion alone; but, so far as

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[English Edition, Vol. XVII., No. 447, pages 304, 305; No. 448, page 264.]

Sir Benjamin's resources enabled him to proceed, there did not then appear to be any direction in which he had not pushed his enquiries.

Dr. ODLING said it was already well known that the method of ultimate analysis failed altogether in discriminating between bodies containing high proportions of carbon and hydrogen. He did not think that Professor Wanklyn had acted wisely in selecting Sir Benjamin Brodie's investigation for the purpose of this kind of criticism, for whilst he questioned the accuracy of published results he had no fresh evidence to offer. It might happen that the acetate of mellissyl was not easily prepared, and we must then have proof that no disintegration of the alcohol occurred; in fact, for his own part, Dr. Odling considered that the *onus probandi* lies entirely on the other side.

Dr. HUGO MULLER made enquiry respecting the mode of preparing the acetate, and the criterion by which its perfect purity might be ascertained. If a little of the alcohol were left unattacked, the fusing point would be considerably raised; even in the comparatively simple case of the decomposition of iodide of ethyl by a silver salt a certain amount of destruction always occurred at the outset, and the change did not exactly coincide with the demands of theory.

Professor WANKLYN, in reply, would refer his enquirers to Sir Benjamin Brodie's original paper, for an account of the preparation of the acetate. It might be made by passing hydrochloric acid through a solution of the mellissic alcohol in acetic acid. The speaker's object in bringing forward this subject for discussion was to show that the methods of investigation formerly in use did not lead to decisive results, and yet the conclusions were reproduced in the chemical manuals without anything to show that they were not so well established as lower terms in the same series. He would again insist upon the propriety of continuing these investigations in the manner pointed out by Berthelot, notwithstanding the objection and abuse which that author had since had to contend with.

Dr. ODLING reminded the last speaker that his idol was not altogether infallible, since compounds of glycerin with acids were described, the highest member of which (containing 4 atoms of acid) had subsequently to be withdrawn.

Professor WANKLYN said this was no fault of the method, but only an error on the part of the operator, which might with greater care have been avoided.

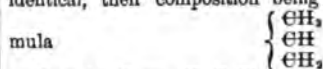
Dr. W. J. PALMER then read a paper "On the production of Saltpetre in India," which led to an animated discussion on the process of nitrification.

Dr. F. GUTHRIE exhibited "An Instrument for Maintaining a Constant Temperature," where gas is available; and the business of the evening was brought to a conclusion by the reading of some Mineralogical Notices, embracing "An account of Chalybite, Diallogite, and Woodwardite," by Professor A. H. Church, M.A. [Abstracts of these papers will be given next week.]

The meeting being the last of the session, was adjourned, at a somewhat late hour, until the first Thursday in November.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Hydrocarbons of the CH_{2n} Series.—A. Butlerow has compared the reactions of the propylene derived from allylic iodide and iodhydric acid with those of the propylene from amylic alcohol, and arrived at the conclusion that they are identical, their composition being represented by the formula



—(Zeitschr. Chem., N. F. iii., 682.)

NOTICES OF BOOKS.

The Stock-Feeder's Manual: the Chemistry of Food in relation to the Breeding and Feeding of Live Stock. By CHARLES A. CAMERON, Ph.D., M.D. London and New York: Cassell, Petter and Galpin. 1868.

THE basis of this work, we learn from the author's preface, consists of some papers on the Chemistry of Food, read before the Royal Agricultural Society of Ireland and the Athy Farmer's Club, and a few articles on the Management of Live Stock, published in the *Weekly Agricultural Review*. It describes the nature of the food used by the domesticated animals, explains the composition of the animal tissues, and treats generally upon the important function of nutrition. The most recent analyses of all the kinds of food usually consumed by animals of the farm are fully stated; and the nutritive values of those substances are in most instances given. Some information is afforded relative to the breeds and breeding of live stock; and a division of the work is wholly devoted to the consideration of the economic production of meat, milk, and butter. Our readers will see from this brief outline of the contents that Dr. Cameron has produced a book likely to interest a large and increasing class of the community, and a careful perusal of its pages will show that it is one which may be read with interest by the mere consumer of the three staple articles of food above named, as well as studied with profit by the producer.

The author is thoroughly practical in his treatment of the subject. He regards an animal simply as a mechanism by which meat is to be manufactured; and he draws the reader's attention to five economic points:—The first cost of the mechanism, the expense of keeping the mechanism in working order, the price of the raw materials intended for conversion into meat, the value of the meat, and the value of the manure. In proportion to the attention given to these points will be the feeder's profit.

The chemistry of food, and the value of different kinds of meat, are gone into very fully. The evils resulting from over-fattened, over-driven, or positively diseased meat, are discussed at length; and here Dr. Cameron, in his capacity of analyst to the City of Dublin, is able to speak from his own experience to the large amount of meat, unfit for human food, which is brought to our large markets; 30,000 lbs. weight of bad meat being the probable quantity offered for sale in London alone every week, 2,000 lbs. of which are condemned by Dr. Letheby in the limits of his jurisdiction.

CORRESPONDENCE.

Preparation of Litmus Paper.

To the Editor of the CHEMICAL NEWS.

I HAVE had much trouble in obtaining a thoroughly satisfactory litmus paper. When used with blotting paper it is not as delicate as could be wished, and on one occasion when attempting to make it with sized paper, the blue tincture persistently turned red when it touched the paper. The latter reaction seemed to be due to the sizing material, and it occurred to me that if I sized some paper myself with pure gelatin, my object would be obtained.

I can recommend the following receipt:—

"Digest 20 grm. litmus with 100 c.c. water for some time, shaking occasionally; then filter. To the filtrate add a slight excess of nitric acid, and boil; then neutralise exactly with potash. Now make a weak solution of gelatin by boiling 1 part of isinglass with 50 parts of water; draw white blotting paper through this and hang it up to dry. When dry paint one side with the above solution of litmus."

A. VACHER.

20, Great Marlborough street, May 30.

Science Teaching in Schools.

To the Editor of the CHEMICAL NEWS.

SIR,—The remarks that have lately appeared in the pages of the CHEMICAL NEWS, by Messrs. Rodwell, Johnson, Oscar Browning, Tomlinson, and Bloxam, on the subject of science teaching in schools, will have been read with interest by many who, like myself, are engaged in this important work. As I believe that few things are more likely to lead to the formation of definite opinions as to the possibilities and impossibilities of the various schemes that have been suggested, than a comparison of notes and interchange of ideas amongst those who are so engaged, I propose to say a few words on some of the statements advanced by the writers referred to, and then to give, very briefly, an outline of what we are doing at Rugby, stating some of the results at which we have arrived.

In the first place, then, I fully agree with Mr. Tomlinson's remark, that boys are good observers but bad theorists. I believe that it is essential to success to realise this. And it is those alone who have had considerable experience with boys who seem able to do so. My own experience extends now over fourteen years, and the last few years have more than ever convinced me of the necessity of admitting this as an established fact. Holding this view, I cannot but think that the prominence Mr. Rodwell assigns to theory in chemistry would be fatal to success with the majority of boys. Of course with senior and advanced pupils we may go as far into theory as we like, and in a large school there will probably be some who are quite fit for reading of this kind; but I am speaking of lecturing on chemistry to classes composed of ordinary schoolboys, with no special aptitude for the subject. Mr. Rodwell asserts "that to thoroughly master the vibratory motion theory as applied to the explanation of chemical phenomena, is better, as a mental exercise, than the knowledge of fifty of the applications of chemistry;" and he goes on to say that "science applied to the useful arts—to the making of dyes, the extraction of metals, the manufacture of coal gas—has ceased to be pure science." I fully and entirely agree with Mr. Rodwell that chemistry is not to be taught to boys because it admits of such applications, and so has a kind of money value; but, at the same time, I can only say that, in lecturing on aluminium, for instance, I should be sorry to lose the additional interest that I always find given to the subject by showing, and that experimentally, the application of the peculiar properties of alumina to the processes of dyeing and calico printing. And so again with regard to coal gas and coal tar colours, as a sequel to a lecture on carbon. I have not the slightest sympathy with so-called popular science. I believe science to be quite as hard as Latin and Greek, and to require at least as great an exercise of the mental powers to master it. But for all this, I do not see why the more important practical applications of science are to be thought unworthy of a place in the lecture-room.

Next, with regard to method of teaching. Mr. Johnson suggests that, as a lecturer on science can hardly be expected to undertake the drudgery of drilling his boys in elementary notions, meaning of terms, &c., his lectures should be supplemented by another master, who would be contented "to go over the ground again, and pick out the weeds that the lecturer had left behind." Without saying anything of the improbability of finding many men competent and willing to do this not over-exciting work, surely it ought, in itself, to be unnecessary. No lecturer ought to get on faster than his pupils can follow him, and he can only ascertain this by constant oral questionings during the lecture, followed, if need be, by repetition and additional explanation of what has been said before. This, it seems to me, is just the difference between a popular lecture in a town-hall, and a scientific lesson in a school-room. Of course the rate of progress through the subject will be slow, but anyhow it will be sure. And I am convinced that, with regard to science, it is better to teach even a very small amount thoroughly well, than to get over a much larger extent of ground superficially. Mr.

Johnson says, "we who live with boys, and become or remain like boys, know better than the lecturer knows their shoals and fogs of misconception, their power of forgetting, &c., &c."; but this is assuming that the lecturer is not one of the regular resident masters, and so long as this is the case, he certainly would be at a distinct disadvantage. Mr. Oscar Browning, indeed, proposes that scientific information, as distinguished from scientific training, should, as a rule, be taught by such itinerant lecturers. As a first step towards introducing the study of science into a school, this would be all very well, and no doubt it would give a kind of impulse, and awaken interest and aptitude in particular boys. But I should be sorry to see the scientific teaching of a school entrusted to any but regular resident masters.

There is another point in Mr. Browning's paper that, I think, calls for some observations. Mr. Browning urges the introduction of applied mathematics in the form of statics, dynamics, and hydrostatics into schools, and he "sees no reason why these subjects should not be obligatory upon all the scholars." Now I cannot believe that the mass of boys in any public school are sufficiently advanced in mathematics to be able to take up such subjects as these, treated *mathematically*. For those who are sufficiently advanced these studies would be excellent; but I understand Mr. Browning to advocate their general introduction as the staple of the scientific work of the school, chemistry and other branches of science being only taught in exceptional cases.

I can only say that my experience goes to prove that the majority of boys in a public school find quite sufficient difficulties in following a course of lectures on elementary mechanics, including little more than the mechanical powers and the simpler forms of mechanism, treated graphically and arithmetically, not *mathematically*.

I believe that mechanics, hydrostatics, and pneumatics, treated experimentally, with such explanations as involve little more than general reasoning, are exceedingly valuable subjects for school work, and might well form a part in any complete scheme of scientific instruction, but their mathematical treatment must, I feel sure, be reserved for the more advanced pupils.

I will now say a few words with regard to our work at Rugby. The school is divided into:—the lower school, containing 50 boys; the middle school, consisting of two divisions, upper and lower, with a total of about 270 boys; the upper school, with 135; and the highest, or sixth form, with about 45. The average age of the boys in the lower school may be said to be 14; in the two divisions of the middle school, 15 and 16; in the upper school, 17; and in the sixth form, 18.

In the lower school natural science is not taught at all. In the middle school every boy learns some branch of it; and in the upper school and sixth form the boys are allowed to choose between natural science and German, the result being a pretty equal division of the two subjects. In the lower middle the subjects are botany, physical geography, and very elementary mechanics. In the upper middle, the botanical work is continued, physical geography is supplemented by geology, and a higher course of mechanics and mechanism is commenced. In the upper school geology and chemistry are, at present, the only subjects taught, and in the sixth form chemistry alternates with some branch of experimental physics. The work is shared between five masters, who give two lessons a week (of one hour each) to each "set." Rough notes are taken by the boys during the lecture. These are afterwards elaborated into note-books which are shown up to the master at regular intervals; they are looked over and corrected by him, and then returned.

Of the success of the botanical work, as a commencing subject, we have not a doubt. It has proved itself to be quite within the grasp of the younger boys. They do it exceedingly well, and are greatly interested in it. They gain from it ideas of terminology, classification, and generalisation, that prove of real value to them in their subsequent progress.

The mechanical work is more difficult; but many boys

have a natural bent in that direction, and those who are fair mathematicians frequently enter into it with ardour. Indeed, there are certain portions of the subject that I have always found to greatly interest the whole class. I refer to the application of mechanical principles to roofs, bridges, buttresses, and the theory of construction in general.

Geology, again, is a subject in which many boys take a real interest. But to study geology satisfactorily implies a larger stock of preliminary knowledge of chemistry, mineralogy, and natural history, than most boys can bring to the task. For this reason, geology is, perhaps, hardly quite satisfactory as a study for schoolboys.

With regard to chemistry I have one or two things to say. There is some uncertainty as to what is generally meant by *teaching* chemistry. In most cases, I believe, it means simply delivering lectures on the metallic or non-metallic elements, with more or less of experimental illustration.

Of course a good deal of information may be given in this way; but I have a strong opinion that this is not sufficient to make chemistry a really effective instrument in a school. I believe that the boys must work and experiment for themselves in order to make the knowledge their own. The most satisfactory results would, I cannot but think, be obtained by making the lessons alternately oral and practical—the teacher explaining at one lecture certain principles and processes, and the boys themselves at the next attempting to carry these out experimentally in the laboratory, of course with sufficient assistance and supervision. Professors Eliot and Storer (whose book I find most valuable as an experimental guide with my own pupils) tell me that this is the plan they adopt in America with very large classes, and they speak with enthusiasm of the gratifying results. Our laboratory at Rugby is too small to enable us to carry out this plan fully at present, but a larger laboratory is about to be built, and then we shall give it a fair trial.

There are many boys, however, who go through what is called a course of chemistry at school without ever touching practical analysis, and yet I believe that this is, educationally speaking, the most valuable part of the subject.

I have for years entertained a strong opinion of the benefits to be derived from the study and practice of chemical analysis, simply as a scientific training, independently altogether of any utility in the knowledge obtained. It has always appeared to me to be almost perfect in the variety of mental faculties which it calls into exercise, and in the example it affords of method in the investigation of truth. All this is shown with great force by Professor Williamson in the second number of *The London Student*, and, so far as I am aware, it is the first time that the peculiar claims of this branch of chemistry, in an educational point of view, have been insisted on. I have daily opportunities of watching the interest that many quite young boys take in working out their analyses in our laboratory, and I have often felt convinced that in no part of their school work are their minds more thoroughly in a state of real activity than when so engaged.

I fear that I have already taken up too much of your space, and therefore forbear to go more into details. I will only remark, in conclusion, that we by no means regard our natural science arrangements at Rugby as complete, since we are greatly hampered for want of more accommodation in the way of lecture rooms, &c. As soon as our new buildings are erected we shall introduce much more of experimental science. Elementary hydrostatics and pneumatics will then probably take the place of geology in the middle school, and electricity and heat will form part of the regular work of the upper school and sixth form.—I am, &c.,

T. N. HUTCHINSON, M.A., F.C.S.

Rugby, June, 1868.

Utilisation of Water Power.

To the Editor of the CHEMICAL NEWS.

SIR,—The question of our coal supplies must interest every

one who has the prosperity of his country at heart; and Professor Jevons's lecture at the Royal Institution, printed in your Journal of 8th and 15th May (*Am. Repr.*, July, '68, page 38), is calculated to produce, if not fear, at least thoughtfulness for the future.

It seems to me that one very obvious source of power, continually passing before our eyes as if inviting thoughtful consideration, has been thrown very much to one side as unworthy of taking a place beside steam. I refer to water power. This neglect may have been of little consequence hitherto, when coals were so plentiful and cheap; but now, when there is every prospect of coals becoming both scarce and dear, and when our growing knowledge of the convertibility of force tends to render the cheapness of the first power everything, and direct application a secondary matter, this neglect becomes a matter of importance.

Every one living in the neighbourhood of a river must be struck by the vast amount of force that passes *unutilised* down the river course during floods. Reckoned up in horse power or foot pounds it must be something enormous even in our smaller rivers. Can this force be *utilised*? The Dutch have wrested land from the depths of the sea. Is it too great a task for the English to hold back the winter floods from the ocean, and only let them out after performing their allotted task? In truth this has been done to a small extent already in our various water works, and I would suggest its being carried out to an extent worthy of the energies of this great nation meeting a threatened difficulty, and subduing the forces of nature to its own use. With the aid of the capital and enterprise of the nation, I should think there is no scientific difficulty in constructing large reservoirs at the sources of our principal manufacturing rivers, supplemented, if necessary, by smaller reservoirs along their courses at suitable points. In our northern rivers, at any rate, there are many natural basins which could with little difficulty be turned into reservoirs capable of storing abundant supplies for the largest manufactories, and keeping these supplies constant during the whole year. By this means one great objection to water power, namely its variability, would be removed.

In the application of water power also much might be done. We are merely on the threshold, so to speak, of our knowledge of the convertibility of force, and for those purposes where the direct application of water power would not be advantageous, it might be converted economically into any other force, such as electricity or heat, without making an impossible demand on our scientific skill.

Mr. Jevons seems to think electricity can never supersede coal, because coal is likely to be the cheapest source of electricity, but if electricity were derived from water power this difficulty would be removed.

Were some such plan as I have sketched adopted, this country would be in possession of a power which would last while the sun shone and rivers flowed, and the seats of industry would not be the plains of Africa or Australia, as Professor Jevons hints, but would still be in "this cloud obscured Isle,"—and because it is cloud obscured.—I am, &c.,

Currie, 10th June, 1868.

W. M. DURHAM.

On Numerical Formulae.

To the Editor of the CHEMICAL NEWS.

SIR,—I have found the following plan to be of service as a means of fixing the atomic weights in the memory, and possibly it may be found useful for the like purpose by some of your numerous readers.

With this object in view, I use occasionally formulæ constructed without any letters whatever, the atomic weight of each element being used as its symbol. Between each set of figures a stop is placed; brackets are made use of

when requisite, and the number of atoms or molecules entering into any reaction is always represented by a small figure.

I subjoin a few formulæ, and an equation constructed on this plan:—

Hydrochloric acid.....	1.35'5
Water.....	12.16
Ammonia.....	13.14
Marsh-gas.....	14.12

The action of iodine on caustic potash is represented thus:—

$$1276 + (1.39'1.16)_2 = 39'1.127.16_2 + (39'1.127)_2 + (12.16)_2.$$

Or, iodine *plus* caustic potash gives potassium iodate, potassium iodide, and water.

While upon this subject I may mention that the formulæ of compounds of carbon, hydrogen, oxygen, and nitrogen with each other, when required to be written down rapidly, may be conveniently represented by using the figures only which indicate the number of atoms in the ordinary formulæ. Of course the figures must always be written in one and the same order. For example, the first figure may be used to express the number of atoms of carbon; the second, the hydrogen; the third, the oxygen; and the fourth, the nitrogen. Should one or more of these elements be wanting, a cipher, or ciphers, may be used to supply its place, and thus indicate the meaning of the following figures.

Formulæ constructed on this last plan are not, as a rule, more than half the length of those in which symbols are used, and may be read by any one with the greatest ease.

In constructing tables containing a large number of formulæ of organic compounds, this omission of the symbols will be found to economise space.—I am, &c.,

JOHN NEWLANDS, F.C.S.

Oberlahnstein, on the Rhine, June 8th, 1868.

Salt and Radical.

To the Editor of the CHEMICAL NEWS.

SIR,—In continuation of the subject for which you have kindly allowed me space in your journal (No. 443, *American Repr.*, July, 1868, page 53), I beg to make a few remarks upon the meaning of the terms salt and radical. What is a salt?

Although the term salt is in constant use in the text-books, there is perhaps no chemical expression so little understood by schoolboys as this. One would naturally suppose that a word so frequently used possessed some definite meaning; yet the boy who takes up his text-book to find a definition of the word salt would be woefully disappointed, the fact being that at present chemists cannot state clearly, shortly, and concisely what they mean by the word; and hence the absence of any adequate definition, and the present cloudiness of ideas concerning it.

But, Sir, I am fain to believe that if that mischievous substantive "acid" were deprived of all chemical significance, and be used in chemistry only as in common life, to denote an acid taste, just as we use the term sweet, some reasonable, if not absolutely correct, definition of the term salt may be arrived at. Something, at least, sufficiently definite to enable the master to teach by, and to satisfy the natural craving of the student for a meaning to the word he is compelled to use.

Before I endeavour to define the term salt, I must ask permission to consider the chemical bearing of the term radical.

1st. Every element is a radical, because it can, without suffering decomposition, enter directly into combination to form a characteristic class of salts. This fact is not broadly and plainly stated in our text-books.

2d. Although every element is a radical, every radical is

not an element. To chemists this assertion may seem self-evident and gratuitous, but we are apparently afraid to make a full admission of the meaning of the word radical in our text-books, and surely we cannot be too plain and simple with beginners.

For all purposes of elementary teaching I would broadly define a radical to be any body that, without itself suffering decomposition is capable of entering into chemical combination with another.

Further, radicals are either simple or compound, real or imaginary. Simple radicals are the elements; compound radicals are such bodies as Cy , &c.; and imaginary radicals, as SO_4 , NO_3 , &c., are those which have never been isolated, and, like atoms, only exist in the mind and imagination of the chemist, created for his own use and convenience, but rendering the acquirement of the science by the young much more difficult than it would be without them.

If these views of a radical be correct, a salt will be any compound formed by the union of two or more radicals, and will take its characteristic place and name from the radicals composing it. From this definition it would result that a compound radical is already a salt. If, however, a compound be capable of uniting with another, or taking part in a chemical equation without itself suffering decomposition, it should receive the name radical, compound radical, or salt radical, to distinguish it from a true salt.

Thus HCl , HNO_3 , and H_2SO_4 , are true salts composed each of more than one radical. If these bodies are salts with a sour taste, let us teach that they are such, and not that they are a special class of chemical compounds capable of generating salts; for radicals, not acids and bases, are the bodies of which salts are composed.

There is, perhaps, nothing more difficult to give than good definitions, and I am well aware that my own are very likely to provoke severe criticism. I trust, however, that the propriety of having something more teachable with regard to the terms commonly used in chemistry, will recommend itself to all, and that whatever my shortcomings may be in this attempt to obtain a general accord as to the terms taught in our schools, and the meanings to be attached to them, my labour will not have been in vain if only something definite be settled upon.—I am, &c.

THOMAS WOOD, Ph.D., F.C.S.

Laboratory, 23, Grove st., Lisson Grove, N.W.

Utilisation of Water-power.

To the Editor of the CHEMICAL NEWS.

SIR,—In the CHEMICAL NEWS of September, 1863 (*Eng. Ed.*), appeared a letter from me on the conversion of water or wind power into light and heat by means of magneto-electricity; permit me to give a few considerations as the result of subsequent attention to the subject. The magneto-electric machine is the cheapest known source of electrical power, and would effect an immense saving of coal for lighting purposes. A good and cheap self-acting electric lamp is, however, necessary for this, and attention should be drawn to the subject. Magneto-electric machinery, driven by steam-power, would save at least half the coal now used in gas-works, while producing more light. Details could be furnished on this point showing a much greater probable saving than one-half.

Magneto-electric machinery driven by water-power would, of course, save all the coal used in gas-works. There are many districts with reliable water supply in which this great result might be obtained.

On the appearance of Professor Way's mercurial electric lamp, you showed in a leading article the ease and advantage with which conducting wires might be fixed from a central light-producing, magneto-electric factory, along streets and into houses. Would it not be true economy to capitalise some portion of our coal by employing steam-power to excavate tidal basins at some of the many suitable

points around our coasts for utilising tidal force in driving various forms of machinery, thus exchanging a fleeting for a permanent motive power? The conclusions of Mr. Jevons add force to this suggestion.

Mr. W. M. Durham, in his interesting letter last week (*American Repr.*, Aug., 1868, page 99), advocates the construction of reservoirs for storing winter floods and storm-waters in rivers for motive purposes. The entire subject well deserves attention.—I am, &c.,

G. ALEX. KEYWORTH.

Hastings, June 22nd, 1868.

P.S.—As regards economy of fuel, it would be important to know whether the plan suggested, I think by Professor Tyndall, has been tried of covering the boiler and other heated parts of the steam engine with an iron-cased lining tightly filled with powdered gypsum—G. A. K.

Royal School of Mines.

To the Editor of the CHEMICAL NEWS.

SIR,—I feel considerable interest in the subject of the School of Mines, having served an apprenticeship after the fashion common amongst the coal miners of the north of England, and having all my life studied how my mining education might have been more thoroughly carried out.

I have met with several French mining engineers, and thus had the means of comparing my own science and practice with theirs, and also in the same way I have come across gentlemen educated at the Royal School of Mines in London.

You and the majority of your readers know what it is to be able to form an opinion which is satisfactory to yourself, and upon which you have no hesitation in acting; it is a condition only arrived at by personal experience obtained in the observation of facts, assisted by the mind educated to appreciate the value of all things seen which have any bearing upon the matter in question.

Now as far as I have been able to judge from what I have seen of the college-made mining engineers, they have been supplied with the "educated mind," but have been allowed to get too old readily to absorb the practical experience; a man of twenty-one does not like to begin the rudiments of practical life, and most assuredly he cannot obtain them during the vacations; there must be a considerable amount of every-day life for a man to get practical experience.

What I have to suggest is that the system prevalent amongst doctors and lawyers should be adopted. Let each mining student serve a regular apprenticeship to a mining engineer in practice, and combine it with the theoretical college studies.

In order to do this effectually, colleges should be instituted in the centre of mining districts. For a Doctor of Physic or Divinity it does not particularly matter where he is educated. The former has the London Hospitals and abundance of subject matter under his very nose, where he can work up his practice in special paths not open to him in his country life, but for the London mining student, what has he to study in practice? unless he perhaps indulges in a field day amongst the sewers or underground railways.

Do not for a moment suppose that I wish to depreciate the value of college studies; but I think a man can more readily pick up theory while in practice than he can after becoming a man bring himself down to the details required to get practice; and I therefore say, bring your schools to the mines, and don't continue to try to take the mines to the schools. Have a college for science in London, as suggested by "Delta" and "A. L. E.," if you like, but don't call and use as a College of Science a School of Mines.—I am, &c.,

A. L. S.

Rule of Thumb.

To the Editor of the CHEMICAL NEWS.

SIR,—The following astounding mixture for tempering steel

chisels is given by a man, signing himself *Practical Experience*, in the pages of one of your contemporaries. When such absurdities as this pass current every week for scientific information, can there be a doubt of the necessity of elementary chemical instruction amongst the working classes? If it did no other good, it would at all events disclose to them the depth of their own ignorance, and teach those with *practical experience* not to be so ready to sneer at *science* :—

"The following is the mixture I have used :—Soda 2 oz., saltpetre 1½ oz., prussic acid 1 oz. (or oil of vitriol 2 oz.), soft water 3 gallons."

I am &c.,

F.R.S.

MISCELLANEOUS.

Adulteration of Wines.—It is much to be regretted that cheap wines advertised and offered to the public as pure and wholesome, are adulterated with alum, and other ingredients of a most deleterious nature. Dr. Barbier, in the *Gazette Medicale de Lyon*, states that he has treated a whole family, in vain, for acute pains in the stomach and indigestion. At last he had their wine analysed, and found no less than two drachms of alum in the bottle. As soon as their wine was changed, their gastralgia ceased. We have ourselves obtained samples of so-called *pure claret*, which we have reason to believe contained a considerable quantity of alum; it is therefore evidently necessary for those who are accustomed to drink these wines, to have some guarantee of their purity.

Lighting the Street Lamps by Electricity.—The street Gas-Lighting Machines by Electricity, to be seen at No. 7 Duane street, are really wonderful, and we see no reason why they should not be generally adopted by all the cities using gas for lighting, on the points of economy and convenience. It is a simple, small machine placed in each lamp-post and connected by insulated wires with a central point, where the operator can, by simply starting the clock-work attached to the batteries, at once open the clocks in each lamp and light up a whole city in the twinkling of an eye, or put out the lights at his pleasure. We notice by our Mayor's late inaugural address, that 38,000 dollars is the estimate for labour and lighting of the city street lights. The labour and the amount of gas that would be saved in the time allowed for lighting and putting out, and the amount that is now used on bright moonlight nights, constitute an aggregate and no doubt would more than pay for the whole expense of introducing the improvement for the first year. The experiments at Duane are worth witnessing by all.—*N. Y. Times*.

The Secrets of the Ocean.—Mr. Green, the famous diver, gives the following sketch of what he saw at the "Silver Banks," near Hayti :—"The banks of coral on which my divers were made are about forty miles in length, and from ten to twenty in breadth. On this bank of coral is presented to the diver one of the most beautiful and sublime scenes the eye ever beheld. The water varies from ten to one hundred feet in depth, and so clear that the diver can see from two to three hundred feet when submerged, with but little obstruction to the sight. The bottom of the ocean, in many places, is as smooth as a marble floor; in others it is studded with coral columns from ten to one hundred feet in height, and from one to eighty feet in diameter. The tops of these more lofty support a myriad of pyramidal pendants, each forming a myriad more giving reality to the imaginary abode of some water nymph. In other places the pendants form arch over arch; and, as the diver stands on the bottom of the ocean, and gazes through in the deep winding avenues, he finds that they fill him with as sacred an awe as if he were in some old cathedral which had long been buried beneath old ocean's wave. Here and there the coral extends to the surface of the water, as if the loftier

columns were towers belonging to those stately temples that are now in ruins. There were countless varieties of diminutive trees, shrubs, and plants, in every crevice of the corals where water had deposited the earth. They were all of a faint hue, owing to the pale light they received, although of every shade, and entirely different from plants that I am familiar with that vegetate upon dry land. One in particular attracted my attention; it resembled a sea fan of immense size, variegated colours, and the most brilliant hue. The fish which inhabit these 'Silver Banks' I found as different in kind as the scenery was varied. They were of all forms, colours, and sizes—from the symmetrical goby to the globe-like sunfish, from the dullest hue to the changeable dolphin."—*Journal of the Telegraph*.

Artificial Gems.—The base of these gems, as patented by the superintendent of the Royal Porcelain Works at Berlin, is a flux obtained by melting together 6 drachms of carbonate of soda, 2 drachms burnt borax, 1 drachm saltpetre, 3 drachms minium, and 1½ ounces of purest white sand. To imitate in colour, but of course not in composition, the following minerals, add to the flux the ingredients named in connection with each gem :—*Sapphire*.—10 grains carbonate of cobalt. *Opal*.—10 grains oxide of cobalt, 15 grains oxide of manganese, and from 20 to 30 grains protoxide of iron. *Amethyst*.—4 to 5 grains carbonate of peroxide of manganese. *Gold Topaz*.—30 grains oxide uranium. *Emerald*.—20 grains protoxide of iron, 10 grains carbonate of copper.

Carbolic Soap.—The beneficial effects experienced by the use of the medical carbolic soap, have led the patentees, Messrs. McDougall Bros., to introduce it in a form suitable for the toilet. The antiseptic properties of carbolic acid are well known to our readers and the form in which it enters into the composition of this soap renders its use pleasant, refreshing, and perfectly harmless. We have no doubt that as the soap becomes known it will be more appreciated, and command an extensive sale. Messrs. McDougall Bros. are also manufacturing a common carbolic soap for household use, which is valuable for cleansing purposes, and also to prevent contagion.

Disinfectants at Terling.—The *British Medical Journal* gives the substance of an official report by Dr. R. M. Grover, Medical Officer of the Millbank prison, who was sent down to Terling by the Home Secretary to superintend the application of disinfection by carbolic acid on an extensive scale during the recent epidemic. Dr. Grover says :—"My instructions were to assist in the endeavour to arrest the epidemic of intestinal or typhoid fever prevailing in that village, by means of carbolic acid. I was desired to take with me a supply of carbolic acid for immediate use; to superintend its application in the first instance; and to give every information to the local authorities as to its use and management. I now beg to state briefly the means to which I have recourse for carrying out these instructions, and the apparent effect of the use of carbolic acid in arresting the spread of the fever. On Monday, February 17th, with the concurrence of the local authorities, I caused a strong solution of Calvert's carbolic acid to be distributed over the entire village. Large quantities of the solution were poured into the cesspools; and it was freely applied to the filthy yards, courts, and stagnant ditches by which many of the houses were surrounded, as well as to the manure heaps, collections of refuse, and other nuisances with which the place abounded. The village may be said to have been soaked with the acid, and the atmosphere became highly charged with its vapour, which found its way, in very considerable volumes, into the dwellings of the sick and healthy alike. This process has been daily repeated up to the present time; and I have advised the local authorities to continue the use of carbolic acid during the ensuing spring and summer months. Many of the inhabitants at first fancied that the smell of the acid produced headache, and for a few days the inspector of nuisances, who was employed in its distribution, was the most unpopular

lar person in Terling. This objection, however, has been overcome; and at my second visit on the 18th instant, no complaints were made, although the presence of carbolic vapour in the atmosphere was to be detected at a considerable distance from the village. The epidemic prevailing at Terling was the common intestinal or typhoid fever, a preventable disease which kills annually no less than 20,000 of the population of this country. Out of a population of 900 persons, about 300 have been attacked with intestinal fever since the 4th December, and of this number 41 have died. With the exception of a lull of a few days in the third week of February, fresh cases continued to occur almost daily up to the end of the month, while only two persons have been attacked since the 1st of March. The carbolic acid was first extensively used, as already stated, on the 17th February; and, allowing ten days for the expiration of the period of incubation, or period of latency, there can be no question that the subsidence of the epidemic corresponds, in point of time, with the date at which the purifying influence of carbolic acid might antecedently have been expected to become manifest. That incredible quantities of fecal matters had accumulated in uncovered cesspools, open ditches, &c., and had soaked into the soil, admits of no doubt; and there can be as little doubt that the decomposition, or, in the language of chemists, the putrefactive fermentation of these matters, was the essential cause of the fever. The special and characteristic chemical property of carbolic acid is the peculiar power which it possesses of arresting putrefactive changes; and it therefore appears to me reasonable to conclude that the extensive use of carbolic acid and the simultaneous disappearance of the disease, are facts which hold the relation of cause and effect. It will not, I believe, be disputed that our knowledge of the causation of fever points to carbolic acid as being the most powerful agent which can be used for the destruction of that specific poison, which, being absorbed into the human organism, sets up the succession of phenomena known as typhoid fever; and it is to be regretted, therefore, that it was not brought into use at an earlier stage of the epidemic. But, however powerful may have been the action of carbolic acid at Terling, its use as a disinfectant can only be looked upon as a temporary expedient for holding pestilence in check until the contemplated and much needed sanitary improvements have been carried into effect.

Discovery of Rock Salt at Dax.—A mine of rock salt, situated in the Department of the Landes, close to the town of Dax, has been conceded by the Imperial Government of France, and a Company has been formed to carry out the concession by the establishment of salt and alkali works. Its existence was discovered in a singular way. A poor man remarking the profits made by many of his neighbours in working some of the numerous hot springs so abundant in the town of Dax, determined to bore in his garden near the ramparts of the town, in search of hot water. Having pierced about 100 feet through sand and clay, alternating with beds of gypsum, he suddenly struck a hard resistant mass, in which he broke off the end of the boring tool; after numerous and fruitless efforts he succeeded in at length recovering the broken bit, and with it brought up a fragment of rock which proved to be nothing more or less than salt. After this discovery he wisely determined to change the plan of his operations, and to try and bore through the salt with water. With this view a pipe was passed down the soil-pipe as far as the salt, and a second and smaller pipe was placed within it. The ends of both of the pipes were allowed to rest on the salt, and fresh water being poured down the interval between the two pipes, salt water—resulting from the solution of the salt—was pumped up from the inner pipe. Thus by this process of solution the bed of salt was pierced through to a thickness of no less than 50 feet. This layer was subsequently found to overlie a second one, being only separated from it by a thin layer of saliferous clay. A fresh boring has been executed at about one mile from the first, where several

layers of rock salt have been pierced, of a total thickness of 131 feet. The average composition of the salt in its rough state shows that it contains 97½ per cent of pure salt. Mr. Maxwell Lyte has prepared a report of this discovery, in which he says that it would be difficult to find a spot more favourably situated for the establishment of salt works than that in which Dax lies. Besides the salt in question the neighbourhood contains mineral deposits of much collateral interest and value. Lignite is found in large quantities; and both French and English coals can be delivered at a very low price, so that there is every reason to believe that this commercial enterprise will be at once lucrative and important.

Destruction of Nobel's Nitroglycerine Manufactory.—By telegram from Stockholm we learn that Nobel's nitroglycerine manufactory was blown up on the afternoon of the 10th inst. Fifteen persons were killed, and several seriously injured, and great destruction was caused in the neighbourhood of the works.

Chemical Society at Newcastle-upon-Tyne.—We hear that Mr. R. Calvert Clapham and Mr. Freire Marrico are making arrangements to establish a Chemical Society at Newcastle. There are a considerable number of practical chemists in the neighbourhood, and this movement will, in all probability, be well supported. Such a Society, well managed, cannot fail to promote the advancement of practical and theoretical chemistry, and we trust that our columns will soon record the proceedings of the Newcastle Chemical Society, in addition to those of the other learned societies.

A New Lamp.—The French, who were always strong in "lamps," have lately brought out a new invention, which is said to be as brilliant as the oxy-hydrogen and lime lights, while it has the recommendation of being much less costly. Coal gas, intimately mixed with air, is urged with gentle pressure along a tube, and made to pass through a metallic plate, pierced full of minute holes. By this means a vast number of jets are obtained, which, after being driven through a fine tissue of platinum wire, are lighted in the ordinary way. The platinum soon acquires a white heat, and gives out so brilliant a light that it cannot be supported by the naked eye. About one metre of gas is consumed per hour. It is called the *Bourbouze lamp*.—*Oil Trade Review*.

On the Means of Recognising the Source of an Alcohol.—The source of an alcohol is usually ascertained by pouring a small quantity into the palm of the hand, and allowing it to evaporate; as the alcohol is more volatile than the empyreuma, the odour of the latter reveals the origin of the alcohol when the evaporation is almost terminated. But this process is very imperfect, as the alcohol may dissolve fatty substances from the hand, which will modify its odour. It is better to operate in a glass or porcelain capsule; but the following plan is still more safe:—Mix the alcohol with an equal quantity of ether, and then add a volume of water equal to that of the mixture. The ether dissolves the empyreuma, and carries it with it when separating with the rest of the liquid. Then evaporate this ether in a porcelain capsule, and the residue gives the empyreumatic odour so characteristic that it cannot be mistaken. Rum, arrack, cognac, potato, or wood spirit may thus be easily distinguished. The test only occupies a few minutes; but rectified ether must be employed, as common commercial ether also leaves an odourous residue on evaporation.—*Neue Gewerbeblätter aus Kurhessen*.

Dinner to Mr. Watts.—On the 15th instant a complimentary dinner was given at the Freemasons' Tavern to Mr. Henry Watts, F.R.S., by several of his friends and coadjutors, in celebration of the completion of his "Dictionary of Chemistry." The chair was taken by Dr. Odling, and there were also present Dr. Roscoe, Dr. Guthrie, Mr. Hanhart, Prof.

Cary Foster, Dr. Atkinson, Mr. F. Field, Dr. H. Müller, Mr. David Forbes, Mr. A. P. Price, Dr. M. Foster, Dr. Russell, Dr. Gilbert, Dr. Redwood, and some others. Mr. De la Rue, Dr. Frankland, Mr. Abel, and Mr. Greville Williams were unfortunately prevented from attending. In proposing the toast of the evening, the chairman remarked upon the advantages which occurred to chemists from their having compressed into five goodly volumes an accurate abstract of the immense mass of chemical knowledge which had gone on accumulating up to the present time, and he complimented Mr. Watts upon the thoroughness and conscientiousness with which this part of his labours had been performed—that he had not been content with giving crude abstracts of scarcely more crude material, but had produced a complete system of singularly well digested abstracts, bearing upon them the stamp of his own individuality. The chairman further observed that, in addition to its being a storehouse of carefully abstracted knowledge, the dictionary was, in addition, a collection of high-class treatises upon all subjects of great chemical interest; and, although many of these treatises had been contributed by friends and associates of Mr. Watts, who had been glad to support him in his arduous undertaking, others of them, and these not the least meritorious, were the work of Mr. Watts himself, and gave evidence alike of his extensive knowledge and clear philosophical conception. The health of Mr. Watts was then drunk with much enthusiasm; other toasts followed, including "Success to the Messrs. Longmans," and the party broke up after an evening of much enjoyment.

Death of Mr. Capel Henry Berger, F.C.S.—An inquiry was held on Tuesday evening last by Mr. Richards, deputy coroner, at Sion-house, Lower Clapton, relative to the death from the inhalation of poison of Mr. Capel Henry Berger, aged 28 years. Mr. C. Berrow Berger, Sion-house, said that deceased lived with him, and was a colour manufacturer. He suffered for a fortnight past from a very severe toothache, but a dentist advised him to preserve the tooth and bear the pain. He was an accomplished chemist, and he tried all sorts of things to allay his sufferings. On Sunday last while at church he had to sit in a great draft, and that brought on a relapse of the pain. In the afternoon he went to his room, according to his custom, and bolted himself in for the purpose of spending some time in devotion. When his sister called him down to tea she could not make him hear, and ultimately witness broke open the door, and found him lying dead on the floor, upon some flexible tubing which communicated with a bottle of carbolic acid. His face was quite black, and he had vomited. It was clear that he had died from the carbolic acid, but he had not committed suicide. Dr. J. B. Metcalf said that deceased had fixed an elastic tube, 10 feet long, to a large glass jar of carbolic acid, and had then evidently seated himself in a chair, and had inserted the end of the tube in his mouth, for the purpose of allowing a drop of the liquid to fall on the tooth. He had a brass regulator on the tube to control the quantity of the acid, but it did not act efficiently, and the volatile poison overcame him, and he became giddy and fell. Being alone in the room, the poison continued flowing into his mouth, and the heart's action was stopped, and he died. The remedy which he tried was a new one, and the deceased was in the habit of recommending it to his friends. It should never be used without medical assistance. The jury returned a verdict of "Accidental death from inhaling carbolic acid as a cure for the toothache."

"Essay" on Coal, delivered in 1858, by an Oxford candidate to the examiners at Cheltenham:—"Coal is a black mineral. The way they produce it is this: First they dig a large pit in the earth. Then they cut down a quantity of timber and put it in the pit, and cover the whole with peat. Then they burn the timber. After it has been burned once it becomes charcoal, and out of the charcoal they make oxygen gas, with which we light our streets and houses."

Cabalistic Formulae.—In a scientific contemporary published abroad, the following cabalistic equations occur in the description of some improvements which have been patented by Prof. E. N. Horsford, of Cambridge, Massachusetts: $3 \text{ Cal. Po}_2 + 2 [\text{Ho, no}_2] = \text{Cal. 2 Ho. Po}_2 + 2 [\text{Cal. no}_2]$; and again: $\text{Cal. 2 Ho. Po}_2 + 2 [\text{Cal. no}_2] + 2 [\text{Ho. So}_2] + 4 \text{ Ho} = 2 [\text{Cal. So}_2, 2 \text{ Ho}] + 2 [\text{Ho. no}_2] + \text{Cal. Ho. Po}_2$.

Discovery of a Silver Lode.—A lode has been discovered on the banks of the Don, in Tasmania, yielding cobalt, silver, copper, and antimony; an analysis, giving the result, was of cobalt, 4 oz. to the ton; silver, 100 oz. to the ton; and copper, 14 per cent.—*Express*.

Venom of Toads.—The Toad, formerly considered as a creature to be feared, does in reality possess a venom capable of killing certain animals and injuring man. This poison is not, as is generally thought, secreted by the mouth; it is a sort of epidemic cutaneous secretion, which acts powerfully if the skin be abraded at the time of contact. Dogs which bite toads soon give voice to howls of pain. On examination, it is found that the palate and tongue are swollen, and a viscous mucus is exuded. Smaller animals coming under the influence of the venom undergo true narcotic poisoning, soon followed by convulsions and death. Experiments made by MM. Gratiolet, Cloez, and Vulpian, show that the matter exuding from the parotid region of the toad becomes poisonous when introduced into the tissues. A tortoise of the species *Testudo Mauritanica*, lamed in the hind foot, was completely paralysed at the end of fifteen days; and the paralysis lasted during several months. Some savages in South America use the acid fluid of the cutaneous glands of the toad instead of the curara. The venom exists in somewhat large quantities on the toad's back. Heated with ether, it dissolves, leaving a residuum; the evaporated solution exhibits oleaginous granules. The residuum contains a toxic powder sufficiently strong, even after complete desiccation, to kill a small bird.—*British Medical Journal*.

Odoriferous Principle of Fleur de Garance and Garancine Alcohol.—It is a well-known fact, that when ground madder root is prepared into garancine, or fleur de garance, a saccharine liquor is obtained which on fermentation and distillation yields an alcohol which is contaminated with what, for years past, was considered to be methyl alcohol. More recent researches have brought out the fact that the peculiar odour of the alcohol obtained from the washing liquors of the garancine and fleur de garance works is due to acetic ether, and far more largely to aldehyd. The impure madder spirit, as ordinarily met with in trade, is an excellent source from which to prepare and obtain large quantities of aldehyd ammonia by the following method:—From 20 to 30 litres of the impure spirit are placed in a distilling apparatus provided with a long metal (copper) worm, and heated to 60° or 70° C. while at the same time a rapid current of air, or carbonic acid, is passed over the liquid in the still; the distillation is continued until the distillate ceases to give with solution of caustic potash a darkish colouration. To the distillate twice its bulk of water is added, while, in order to decompose the acetic ether, finely powdered hydrate of baryta is added with continuous agitation of the liquid until a decided alkaline reaction sets in; the excess of baryta is removed by carbonic acid. The aldehyd is afterwards separated from the liquid by careful distillation on a water bath, and purified by combining it with ammonia. If the impure madder spirit is agitated with sodium amalgam, perfectly pure alcohol is obtained; since the aldehyd is by this means hydrogenised to alcohol, and the acetic ether is decomposed into alcohol, while acetate of soda is formed.

The Rusting of Iron.—Perfectly pure water will not rust iron until it is heated to redness, when the contact with the metal instantly forms a red crust. Water oxidises iron

more rapidly when it receives small quantities of mineral acids, while on the other hand an alkali or caustic lime destroys the oxidising faculty of water, a fact which is easily explained when we consider what strong affinity carbonic acid has for those bases. We are indebted to FAYEN for the determination of the limits of this veto power which alkalies possess over the oxidation of iron in water. He ascertained that a saturated solution of potassa lye diluted with from 1,000 to 2,000 parts of water could still protect iron, but not when diluted with from 3,000 to 4,000 parts. Saturated lime water, when diluted three times, protected iron, but not when diluted four times. Saturated carbonate of soda, diluted with from fifty to fifty-four volumes, protected iron, but not so when diluted with even fifty-nine volumes. The finest cast steel was protected perfectly by even less potash. Rust is porous, and, like all porous bodies, absorbs gases. White pig metal scarcely oxidises; grey iron with more facility, bar iron still easier, especially when red hot. Cold-short iron rusts least and slowest. Polish is the best preventive of rust, particularly when the article is kept in dry air.—*Scientific American*.

To Make Plaster of Paris Harder.—With one exception, all admixtures impair the hardness of the plaster. The exception is iron filings. When these are mixed with plaster they rapidly oxidise, and the coherent mass of oxide of iron formed adds its own strength to that of the plaster, making a very firm mass, which has also the advantage of strongly uniting itself to surfaces of iron. I have not observed what proportion of the filings is best, but suppose they should form about one-fifth the whole weight.—F. BOWLY.

Royal Dublin Society and the Royal Visit to Ireland.—The Royal Society are to give a *Conversazione* to the Prince and Princess of Wales on their arrival in Dublin. The Society's House in Kildare Street is being prepared for the occasion. The objects exhibited will be of scientific and art interest, particularly the latter. Part of the suite of rooms used for the occasion will be the Natural History Museum, which so far has not been open to the public since the present fine building has been erected. The minerals, &c., have been entirely rearranged.

The Royal Society.—There are 53 applications for the Fellowship this year, eight of them being chemists of some standing.

Colourless Varnish with Copal.—To prepare this varnish the copal must be picked; each piece is broken, and a drop of rosemary oil poured on it. Those pieces which, on contact with the oil, become soft, are the ones used. The pieces being selected, they are ground and passed through a sieve, being reduced to a fine powder. It is then placed in a glass, and a corresponding volume of rosemary oil poured over it; the mixture is then stirred for a few minutes until it is transformed into a thick liquor. It is then left to rest for two hours, when a few drops of rectified alcohol is added and intimately mixed. Repeat the operation until the varnish is of a sufficient consistency; leave to rest for a few days, and decant the clear. This varnish can be applied to wood and metals.—*Journ. Applied Chem.*

Steel Billiard Balls.—Among other new uses of steel, one of the latest is that of the employment of this metal for billiard balls instead of ivory. They are very elastic, and are not liable to crack like those in present use.

Important to Chemists.—This advertisement appears in a Paris paper: "A young lady of forty-eight, having a moderate income, but possessing a patent for a new invention, wishes to marry a gentleman of sixty-five well versed in chemistry."

Rattlesnake Poison.—The following are the conclusions at which Dr. Weir Mitchell has arrived:—1. One-fourth of a drop of the venom is fatal to pigeons under the

age of four months. One-eighth of a drop is frequently a fatal dose. 2. The venom is absolutely harmless when swallowed, because (a) it is incapable of passing through the mucous surfaces; (b) it undergoes change during digestion, which allows it to enter the blood as a harmless substance, or to escape from the canal in an equally innocent form. 3. Twenty-four hours after it has been swallowed, the contents of the bowel contain no poison. 4. The rectum of the pigeon does not absorb the venom, and it causes no injury when placed on the conjunctiva of animals. 5. The venom passes through the membranes of the brain, and more swiftly through the peritoneum and pericardium. 6. When the venom passes through the peritoneum it so affects the walls of the capillaries as to allow of their rupture and of the consequent escape of blood. The same phenomena appear on the bare surface of muscles thus poisoned. This, together with the defect of the coagulability of the poisoned blood, accounts for the excessive hemorrhage about the fang wounds. 7. The blood globules are unaltered in venom poisoning. 8. The rattlesnake is not susceptible of injury by the venom of its own species. 9. The sulphites or hyposulphites of soda or lime have no antidotal power. 10. Carbonic acid sometimes delays the fatal result, and usually lessens local hemorrhage. 11. These effects are due to no influence of the acid on the venom, but to a direct effect upon the local circulation of the envenomed part. 12. Carbolic acid has no value as true antidote, and when given internally does not affect the ordinary fatal issue.—*New York Medical Journal*.

Obituary.—Professor Page.—Professor Charles G. Page, of the United States Patent Office, died on the 5th inst., after a lingering illness. He was the author of many important discoveries in electro-magnetism, and the inventor of an electro-magnetic motive-power engine, which attracted some attention from fifteen to twenty years ago. Prof. Page had for many years been chief examiner in the U. S. Patent Office, of the class termed "philosophical instruments," embracing all inventions in mathematics, mensuration and electricity.

CONTEMPORARY SCIENTIFIC PRESS.

[Under this heading it is intended to give the titles of all the chemical papers which are published in the principal scientific periodicals of the Continent. Articles which are merely reprints or abstracts of papers already noticed will be omitted. Abstracts of the more important papers here announced will appear in future numbers of the "CHEMICAL NEWS."]

Comptes Rendus. February 17, 1868.

I. PIERRE and E. PUCHOT: "Experimental Researches on the Products of the Distillation of Beet-root."—A. HOUZEAU: "On Peroxide of Hydrogen considered as not being the Cause of the Changes produced in Litmus Paper impregnated with a Solution of Iodide of Potassium when used as a Test for Ozone in the Atmosphere."—RAKOWITZ: "On the Use of Chloroform for the Qualitative and Quantitative Examination of Rye Flour and Alcoholic Liquors."

February 24.

A. MALLETT: "A Method of Manufacturing Chlorine and Oxygen from Protochloride of Copper."—BLONDEL: "On the Production of Ozone and Phosphoric Acid during the Slow Combustion of Phosphorus."—LE RIQUE DE MONCHY: "On a Ferment discovered in commercial Bicarbonate of Soda."—MARTIN: "A Method of Preserving Meat by means of Sulphuric Ether."

Annales de Chimie et de Physique. January, 1868.

C. MARIGNAC: "On the Separation of Niobic Acid from Titanic Acid, and on an Analysis of Echinite."—R. RADAU: "On the Static Barometer."—SCHONBEIN: "On the Presence of Ozone in the Atmosphere."—F. ROSETTI: "On the Use of the Thermo-electric Pile for Measuring the Temperature of the Body."—A. BARTHELEMY: "On the Estimation of Carbonic Acid in Bicarbonates and Waters by means of Protosulphate of Mercury."—MUSCULUS: "On the Hydrates of Stannic Acid."—A. BECHAMP: "On the Action of Chalk and the Living Organisms which it contains in Butyrous and Lactic Fermentations."

Bulletin de la Société Industrielle de Mulhouse. January, 1868.

COUPPIER: "On the Red Colouring Matters derived from Toluene."

C. KOECHLIN: "On Pernod's Process for Detecting Adulterations in Garancine and its Derivatives."—G. SCHAEFFER: "On the same Subject."—E. DOLLFUS: "On Thirault's Safranin, a new Yellow Colouring Matter."—G. SCHAEFFER: "On Meister, Lucius, and Co.'s new Aniline Green."—COUPPE: "On the Author's Claim to the Invention of Toluidine and Cumidine Red."—THIRAUT: "On Safranin Red and Safranin Yellow, and on Mureine Grey."—O. SCHEURER: "On the Author's Claim to the Invention of a Method of extracting Red, Pink, and Violet Colouring Matters from Garancine."—PERNOD: "A Method of producing the Shades of Colour between Black and Violet and Red and Pink from an Extract of Garancine."—A. DOLLFUS: "On E. Hafer Grosjean's New Fusible Alloy of Lead, Tin, and Cadmium."—M. ZIEGLER: "On the Presence of Aniline in the Coloured Fluid ejected by the Sea Hare, *Aplysia depilans*."—E. DOLLFUS: "On Thirault's Safranin Yellow."—J. MEYER: "On the same Subject."—THOMAS: "On a new Colouring Matter Extracted from *Soricographis mollis*."—ROSENSTIEHL: "Report on M. Ziegler's Memoir on the Presence of Aniline in the Coloured Fluid ejected by the Sea Hare, *Aplysia depilans*."—HOFF: "On an Extract of Horse Flesh."—J. LEFORT: "On Buckthorn Seeds from a Chemical and from an Industrial Point of View."—C. O'NEILL: "On the Causes of the Explosion of a Boiler used for preparing Resin Soap."—ROSENSTIEHL: "Researches on the Composition of Toluene Red."—REBOULLEAU: "On the Growth of Garancine in Algeria."—KUHLMANN: "On the Action of Water on Lead."—ASSELIN: "On a Process for Refining Vegetable Oils by means of Caustic Soda."—J. ROTH: "On the same Subject."—GERBER-KELLER: "Remarks on Kuhlmann's Essay on the Action of Water on Lead."—KUHLMANN: "Answer to the preceding Remarks."—G. SCHAEFFER: "On the History of the Application of Extracts of Garancine as Colouring Matters for Printing Fabrics."—ROSENSTIEHL: "Report on Asselin's Process for Refining Vegetable Oils by means of Caustic Soda." "Report on the Methods used at Dieuze for utilizing Chlorine Residues and Soda Waste."

Journal für Praktische Chemie. Nos. 23-24. 1867.

G. ROSE: "On the Preparation of Crystallised Bodies before the Eloupe (Continuation), On the Behaviour of Titanic Acid towards Borax, and on the Preparation of Rutile and Amorphous Titanic Acid. On the Behaviour of Oxides of Iron towards Borax, and on the Preparation of Crystallised Hematite and Magnetic Iron Ore. On the Behaviour of Titaniferous Iron Ore towards Borax, and on the Preparation of Crystallised Titaniferous Iron Ore and Titaniferous Magnetic Oxide of Iron. On the Preparation of Rutile by Fusing Titanic Acid and Titaniferous Iron Ore with Phosphate of Soda and Ammonia."—E. HERMANN: "Answer to C. Marignac's Remarks* on the Author's Researches on the Atomic Weight of Niobium and Iminium. On Recendakite, a new Nickel Ore, and on the Extraction of Nickel from that Mineral."—F. VON KOBEL: "On Glaucoedite from Itakabö, Sweden."—HENNING: "On the Theory of the Removal of Sulphur from Gas by Oxide of Iron and of the Rectification of the same."—MILGER: "On the Chemical Composition of the Shell and some soft Parts of living Brachiopoda."—A. FROEDE: "On the Identity of Hydrocarotene and Cholesterine."—A. E. NORDENSKÖLD: "On the Selenium Minerals from the Copper Mine of Skrikerum, in the Province of Calmar, Sweden."

No. 1. 1868.

A. MULLER: "On the Dialytic Solution of Caseine and Starch."—A. CLAUS: "On the Behaviour of Acrolein towards Hydrate of Potash. Contributions to the Knowledge of Oxanilic Acid."

Dingler's Polytechnisches Journal. No. 3. 1868.

A. OTT: "On the Preparation of Phenic Acid."—H. FIEBIGER: "On the Detection of Butyric Acid in Glycerine, and on its Separation from that Substance."—A. SPAN: "On G. C. Nöllner's Method of Estimating Nitric Acid."

Annales du Génie Civil. February, 1868.

A. D'ADHÉMAR: "On the Deposits of Phosphate of Lime at the Island of Sombro, Antilles."—STOSS: "On the Use of Oxide of Chromium for Polishing Steel."—ZIEGLER: "A Substitute for Animal Charcoal."—SCHNEIDER: "A Method of Purifying Coal Gas by means of Iron Filings."—GONDOL: "A Modification of Bousingault's Process for Manufacturing Oxygen and Nitrogen by passing a Current of Atmospheric Air over Caustic Baryta."—SCHWAB: "A Process for Manufacturing Seltzer Water from Carbonate of Magnesia without the Use of an Acid."—PICARD: "A Process for Extracting Grease from Waste Leather."—AUBERTIN and BOBRIQUE: "On obtaining Phosphorus from Bones by means of Silica and Pounded Charcoal."

Comptes Rendus. March 2, 1868.

JUETTE: "On the Estimation of Tartaric and Malic Acid by means of Iron, Aluminium, Manganese, &c."—J. PERSONNE: "Chemical Researches on the Composition of Roasted Coffee."—DESCHAMPS, SEN.: "On the Volatile Oils contained in Brandy. Contributions to the Knowledge of Iodide of Potassium and some other Iodides."

March 9, 1868.

H. DEVILLE: "First Memoir on the Physical Properties and Caloric Power of Petroleum and other Mineral Oils."—FIZEAU:

* See *Journal für Praktische Chemie*, vol. 101, p. 464.

"On the Dilatation of Paraffin and Naphthalene."—E. FREMY and TERREIL: "On a general method for the immediate Analysis of Vegetable Tissues."—A. PATEY: "On the Properties and on the Extraction of Diastase."—A. W. HOFMANN: "On the Member of the Naphthalic Series which corresponds to Benzoic Acid."—ISARD: "A process for Determining the Equivalent of Aluminium."—BICHAMP: "On the Propionic Fermentation of Succinic and Malic Acid."

Monatsbericht der Königlich Preussischen Akademie der Wissenschaften zu Berlin. November, 1867.

RAMMELSBERG: "On the Composition of the Salts of Periodic Acid."

Archives des Sciences. February 15, 1868.

C. MARIGNAC: "On the Reduction of Niobium and Tantalum Compounds."

Annalen der Chemie und Pharmacie. February, 1868.

R. FITTIG, A. KÖHNIG, and T. JUKE: "On the Decomposition of Camphor by Chloride of Zinc in Fusion."—J. H. EATON and R. FITTIG: "On the Cyanogen Compounds of Manganese."—O. MALIN: "On Isodulcitic Acid. Contributions to the Knowledge of Camphor."—H. HILSWEITZ and A. GRABOWSKI: "On the Decomposition of Camphoric Acid by Caustic Potash in Fusion."—W. HEINZE: "On the Action of Iodide of Ethyl on Glycol Compounds and Diglycolamidic Acid Compounds, and on a new mode of formation of Diethylglycol and Ethylglycolamidic Acid."—C. HEHRMANN: "On the Constitution of Ferrocyanide of Cadmium and Potassium."—A. CLAUS: "On the Reduction of Oxalic Acid."

Poggendorff's Annalen der Physik. No. 1. 1868.

A. FORSTER: "An account of some Methods of Preparing Phosphorescent Compounds."—I. WIMMEL: "On the Melting Points of Fats, and on their behaviour during Solidification."—C. SCHULTZ: "On the Constitution of the Sulphates."—C. VON HAUER: "On the Hydrates of the Double Sulphate of Cadmium and Potash."—W. WEGNICKE: "On Gilding Glass Specula."

Bulletin de la Société Industrielle de Mulhouse. February, 1868.

A. SCHEURER-KESTNER: "Memoir on the Extraction of Sulphur from Soda Waste."

PATENTS.

Communicated by Mr. B. VAUGHAN, F.C.S., Patent Agent, 54, Chancery Lane, W. C.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

955. H. Bessemer, Queen Street Place, Cannon Street, London, "Improvements in the manufacture of refined iron and of malleable iron and steel."

957. H. Bessemer, Queen Street Place, Cannon Street, London, "Improvements in the manufacture of malleable iron and steel, and in apparatus used in such manufacture."—March 21, 1868.

978. G. F. Guy, Bury St. Edmunds, Suffolk, "Improvements in the manufacture of sugar and other alimentary substances from beet-root."

983. E. Vignier, Fowkes Buildings, London, "Improvements in distilling and rectifying spirits, and in apparatus employed therein."—March 23, 1868.

1020. T. Whitehouse, Wednesbury, Staffordshire, "Improvements in blast furnaces."

1023. J. Jameson, Catherine Terrace, Gateshead, Durham, "Improvements in the preparation of safety paper."—March 25, 1868.

1044. T. Routledge, Ford Works, near Sunderland, and W. H. Richardson, Jarrow-on-Tyne, "Improvements in bleaching Esparto and other fibrous substances used in paper-making."—March 26, 1868.

1045. A. Warner, Laurence Pountney Lane, London, "Improvements in the manufacture of cement."

1048. A. Scott, Paddington, Middlesex, "The production of an alcoholic fermented dry, sweet, or effervescent drink, of which tea or coffee, or theine or caffeine, is an essential ingredient."

1050. F. Bauman, Wellington Street, Strand, Middlesex, "The preparation of a certain combination of chemical substances, and its novel application to the treatment of wood or other fibrous material in the preparation of paper pulp."—March 27, 1868.

1063. T. C. Currie, Kensington, Middlesex, "An improved process for the preservation of milk."

1067. J. O. Coombe, Holloway, Middlesex, and J. Poole, Chelsea, Middlesex, "Improvements in coating iron, steel, and such like surfaces, and protecting and preserving them from the corrosive action of sea or salt water, and the oxidising influence of damp air, wet, and moisture."—March 28, 1868.

1074. C. F. Claus, Middlesbrough-on-Tees, Yorkshire, "Improvements in the manufacture of malleable iron, and in the process of reheating the same for the purpose of rolling or hammering it."
1076. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the manufacture of cast steel and malleable iron from cast iron, and in the apparatus or means employed therein."—A communication from F. Ellershausen, Ottawa, Canada.
1077. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the treatment of cork, and in the manufacture of a new compound or material therefrom, applicable to various useful purposes."—A communication from H. Hauer and W. Howell, Philadelphia, Penn., U.S.A.
1078. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the manufacture of cast steel, and in furnaces to be employed therein, which furnaces are also applicable to the remelting of metals generally."—A communication from F. Ellershausen, Ottawa, Canada.
1082. A. B. Walker, Warrington, Lancashire, "Improvements in the application of hot blast or heated air for evaporating salt, brine, and other liquids, sugar, or chemicals, also for heating gas and oil retorts, raising steam in boilers, boiling worts in breweries and distilleries, which improvements are also applicable for bleaching, tanning, and baking, likewise improvements in apparatus used in some of the aforesaid applications."—March 30, 1868.
1086. W. Austin, Greville Street, Hatton Garden, Middlesex, "Improvements in the composition, boxes, and surfaces for obtaining instantaneous light from chemically prepared matches intended to be ignited by friction."
1095. H. Bessemer, Queen Street Place, Cannon Street, London, "Improvements in the manufacture of malleable iron and steel, in the heating and melting of metals, and in the machinery or apparatus employed for such purposes."—March 31, 1868.
1102. W. Smith, Glasgow, N. B., "Improvements in the manufacture of pig iron."—April 1, 1868.
1117. J. G. Dale and E. Milner, Warrington, Lancashire, "An improved method of producing white pigments from lead."—April 2, 1868.
1124. C. D. Abel, Southampton Buildings, Chancery Lane, "A new or improved process and apparatus for refining camphor."—A communication from C. E. Peret, Boulevard de Strasbourg, Paris.
1126. J. McCulloch, Shawlands, Renfrewshire, N. B., "Improvements in utilising old or waste tarpaulin in the manufacture of grease and other useful products, and in apparatus therefor."
1130. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the manufacture of cast steel and malleable iron from cast iron, and in the apparatus or means employed therein."—A communication from F. Ellershausen, Ottawa, Canada.—April 3, 1868.
1343. S. Perkins and W. Snellie, Gorton, near Manchester, "Improvements in the manufacture of malleable metal of a steely quality, partly from Bessemer 'scrap' or other Bessemer metal."—December 5, 1867.
1349. L. Rose, Leith, N. B., "An improved mode of preserving vegetable juices."—December 9, 1867.
13517. A. M. Clark, Chancery Lane, "An improved process for the production of tin so as to render it applicable for coating metals, and for other purposes."—A communication from J. Feuquière, Boulevard St. Martin, Paris.—December 11, 1867.
13542. E. R. Sintzenich, Duke Street, St. James's, Middlesex, "Improvements in the treatment of gutta-percha, India-rubber, Honduras gum, and the other allied gums, for the production of a preparation or preparations applicable as a varnish, cement, paint, stain, water and air-proof material, and for other purposes."—A communication from D. Reed, New York.—December 13, 1867.
13559. J. Hargreaves, Appleton-within-Widnes, Lancashire, "Improvements in the manufacture of soda and potash."
13556. A. M. Clark, Chancery Lane, "Improvements in the extraction of ammonia from fermented and other liquids, and in the regeneration of the agents used in such extraction."—A communication from A. Coste and L. T. De Rosnay, Boulevard St. Martin, Paris.—December 14, 1867.
13581. W. Huskisson, jun., Swinton Street, Gray's Inn Road, Middlesex, "Improvements in the manufacture of bicarbonate of potash and soda."—December 16, 1867.
13652. F. A. Abel, Woolwich, Kent, "Improvements in the production of explosive compounds."
13657. A. M. Clark, Chancery Lane, "An improved colouring matter, chiefly applicable for dyeing and printing purposes."—A communication from J. T. Coupler, Boulevard St. Martin, Paris.
13663. J. Addie, Coatbridge, Lanarkshire, and F. Kolm, Westminster, Middlesex, "Improvements relating to blast and cupola furnaces."
13667. G. J. Hinde, Wolverhampton, Staffordshire, and T. O. Hinde, Ynyspenllwch, near Swansea, Glamorganshire, "Improvements in the manufacture of iron and steel, and in furnaces and apparatus used in the said manufacture."—December 24, 1867.
112. T. Whitwell, Stockton-on-Tees, "Improvements in furnaces."—January 11, 1868.
215. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in furnaces."—A communication from H. Ross, Pittsburgh, Allegheny, Penn., U.S.A.—January 21, 1868.
403. W. R. Lake, Southampton Buildings, Chancery Lane, "An improved mode of, and apparatus for, extracting and condensing the volatile portions of ores."—A communication from F. Formhals, San Francisco, California, U.S.A.—February 13, 1868.
1071. H. Armstrong, Tow Law, Durham, "Improvements in the manufacture of steel and homogeneous iron."
1073. C. F. Claus, Middlesbrough-on-Tees, Yorkshire, "Improvements in the manufacture of iron."

731. T. Johnson, Runcorn, Cheshire, "Improvements in treating ores to obtain copper therefrom, and in evaporating brine."—March 3, 1868.
759. W. Hunt, Castleford, Yorkshire, "Improvements in treating certain compounds of copper and iron, and in utilising residual products obtained in heating compounds of copper and iron."—March 5, 1868.
785. J. Houston, Glasgow, N. B., "Improvements in the manufacture of composite candles, and in the machinery or apparatus employed therein."—March 6, 1868.
830. C. Attwood, Wolsingham, Durham, "Improvements in the production or manufacture of steel and iron of a steely character."—March 10, 1868.
891. W. A. Newton, Chancery Lane, "Improvements in the manufacture of illuminating gas in the distillation of hydrocarbons, and the making of gaseous fuel for heating purposes."—A communication from L. Stevens, Washington, Columbia, U.S.A.—March 16, 1868.
923. B. E. R. Newlands, F.C.S., Charlton, Kent, "Improvements in treating and obtaining products from spent oxide of iron which has been used in gas works or otherwise, to separate sulphur from sulphuretted hydrogen, and in the purification of sulphur obtained from such oxide of iron."—March 18, 1868.
1078. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the manufacture of cast steel, and in furnaces to be employed therein, which furnaces are also applicable to the remelting of metals generally."—A communication from F. Ellershausen, Ottawa, Canada.—March 30, 1868.
1130. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the manufacture of cast steel and malleable iron from cast iron, and in the apparatus or means employed therein."—A communication from F. Ellershausen, Ottawa, Canada.—April 3, 1868.
1222. T. Forster, Streatham, Surrey, "Improvements in the manufacture of compounds of India-rubber, gutta-percha, balata, parkesine, solid paraffin or vegetable oils, and vegetable fibre."—April 13, 1868.
1137. H. Cochrane, Middlesbrough-on-Tees, Yorkshire, "Improvements in blast furnaces."—April 4, 1868.
1157. J. Radcliffe, Consett Iron Works, Durham, "Improvements in processes and means employed in the manufacture of iron and steel."—April 6, 1868.
1181. J. James, Ebbw Vale, Monmouthshire, and T. Jones, Govilon, Monmouthshire, "Improvements in the manufacture of iron into semi-steel or steel."
1184. W. E. Newton, Chancery Lane, "Improvements in the manufacture of salts of soda."—A communication from J. M. Gattman, New York, U.S.A.
1187. V. Gallet, Lavanseau de Benassals, Vienne, France, "Improvements in the manufacture of steel."—April 1, 1868.
1195. A. H. Still and D. Lane, Cork, "Improvements in the manufacture of gas."—April 9, 1868.

INVENTION PROTECTED BY THE DEPOSIT OF A COMPLETE SPECIFICATION.

1167. A. L. Holley, Harrisburgh, U.S.A., "Improvements in the manufacture of iron and steel."—Recorded April 7, 1868.

NOTICES TO PROCEED.

3270. G. Flitt, Limehouse, Middlesex, "Improvements in the manufacture of artificial manure."—Petition recorded November 18, 1868.
3288. Baroness C. de Lavenant, Brixton Road, Surrey, "Improvements in coating metals and metallic articles for the purpose of protecting or preserving the same from oxidation and decay, also in the materials, machinery, and apparatus to be employed therein."—Nov. 20, 1867.
3318. P. Salmon, Great Smith Street, Westminster, Middlesex, "Improvements in the manufacture of gas, and in the treatment and application of such and other gases for cooking, warming, lighting, generating of steam, and other purposes, combined with their use as a motive power, previous to being burned or consumed, and improvements in the apparatus for these purposes."—November 23, 1867.
3340. J. P. Smith, Glasgow, "An improved mode of coating and uniting metals with metals."—November 26, 1867.
3360. H. F. Gardner, Boston, U.S.A., "Improvements in the means of, and apparatus for, treating metals and minerals in order to produce their oxides or other chemical or mechanical combinations, and to separate metals from their ores or from their alloys."—A communication from Z. A. Willard, Boston, and W. G. Adams, Franklin, Mass., U.S.A.—November 27, 1867.

NOTES AND QUERIES.

Phosphate of Iron.—Can any of your correspondents give me the chemical composition of the precipitate resulting from the addition of a small quantity of dil. sulphuric acid to a solution of pyrophosphate of iron; and also the reason of its formation?—PHARMACIST.

Solvent for Essential Oils.—Your correspondent (*Am. Repr.*, April, 1868, page 203) desires to be informed whether it is possible to find a solvent for essential oils which would render these soluble in water, without producing therein a milky appearance. To a certain extent all essential oils are more or less soluble in water, but only very slightly so; still orange-flower water, for instance, shows that the fragrance due to the *Oleum Neroli*, as contained in the orange flowers, can be imparted to water in great measure. If "Subscriber" does not desire

or want a perfectly limpid and clear solution, he may make use of the property possessed by essential, as well as fixed oils, of becoming more largely soluble in water by the intermediate of emulsions, or rather mixtures fit to make emulsions, with either essential or fixed oils. Another mode of rendering the essential oils soluble in water, without becoming milky, is to rub the essential oils in small quantity with some sugar and the ordinary magnesia of the chemists' shops in a mortar, to add water gradually, and to filter; gum arabic may be substituted for sugar, and by addition of a few drops of strong acetic acid or pure ether, or better yet acetic ether, the solvent power of water for essential oils may be somewhat increased. It is clear that a dilute alcohol will keep in solution a larger quantity of essential oils than water alone. It is, at least on the Continent, and also in Mexico, a well known fact that the peculiarly delicious fragrance of the vanilla may be thoroughly imparted even to cold water or milk by first rubbing the vanilla to powder along with lump sugar, and gradually adding the water or milk afterwards, and straining through a silk sieve, or filtering; of course an infusion may be made, but its fragrance is less pleasant. "Subscriber" is, I suppose, aware that many essential oils have a boiling-point higher than that of water, and that if it is desirable to make a strong aqueous solution it is often desirable to use hot, but best distilled water, to shake a quantity of the essential oil with the hot water, and allow to cool in a closed or corked bottle, and decant the clear solution.—Dr. A. A.

Aniline Green.—In reply to "Test Tube" (*Am. Repr.*, July, 1863, page 49), I can inform him that aniline green has been produced in the preparation of Hofmann's violet (salts of triethyloxyaniline) in the following way:—The mixture which produces the violet colour is heated to 100°–115° C., not as in the production of violet, for four to six hours, but for a much longer time. After opening the apparatus and distilling off the excess of iodide and alcohol there is obtained a mixture of Hofmann's violet, and a more, or less bluish green colour, which may become even a greenish blue when the operation has been continued for a sufficiently long time. If there is too much violet in the mass, and the green is too blue, it is best to treat the whole once more with the iodide. Some manufacturers treat their product with iodide until the whole or almost the whole is transformed into a green colour, to which they give the yellowish shades by adding picric acid.—BETA.

Vessel for holding Nitric Acid.—"R. C. M." is desirous of information concerning a vessel to hold about 100 cubic feet—1,200 gallons of liquid made up of 1-20th of strong nitric acid and 19-20ths of water, and to hold this mixture by the aid of steam applied inside, which of course implies that steam from a boiler is brought by means of a pipe ending in the liquid with open orifices. "R. C. M." might make the tank of slate; slabs of this material can be had of any size, and, if properly selected, will answer his purpose admirably; the slabs will of course have to be grooved into each other, and the grooves run tight with a resinous cement. As to the material of the steam pipe—"R. C. M." should recollect that neither lead, copper, iron, or tin can in his case serve the purpose, and he would do best perhaps to procure for the inside of the vessel as steam pipe, a tube made of hard pottery ware perforated with small holes; such tube any of the Lambeth potteries, or the works of the Staffordshire pottery district, would make him to order. I suppose "R. C. M." knows that the condensation of steam in the cold fluid will tend to dilute the acid of the mixture, and also to increase the bulk of the fluid inside the tank, the capacity of which should not be less than 200 cubic feet; a tank 10 feet long, 5 feet wide, and 4 feet deep will answer the requirements, inside measurement.—Dr. A. A.

Aniline Green.—Cathartic Acid.—I reply to "Test-tube," (*Am. Repr.*, July, 1863, page 59), concerning aniline green and cathartic acid, the following:—I am not aware that there exists any iodine green; perhaps "Test-tube" may try picric acid, also called carboxylic acid, and indigo solution, as "Test-tube" must be aware that nearly all green dyes are made up from the mixtures of yellow and blue dyes. A genuine green, known as Chinese green, or Lo-kao, is obtained in China from *Rhamnus chlorophorus* and *utilis*; the berries of *Rhamnus cathartica*, a plant met with in Southern Europe, yields the sap-green. "Test-tube" is mistaken as to his notion on senna leaves; the tree which yields these has nothing at all in common with the plant just alluded to, neither has cathartic acid with either the purgative properties of senna or the dye value of divers varieties of the *Rhamnaceae*. Lo-kao is, at least in France, a regular article of trade, and pretty extensively used at Lyons, Nîmes, Rouen, and other centres of textile fabrics and dyeing industry of France.—X.

Cast Porcelain.—Can any one tell me what this material is? It is being manufactured in America on a somewhat large scale, and from some specimens which I have seen, it must be a very beautiful substance. Is it ordinary glass devitrified?—SILEX.

Sulphide of Magnesium.—Can any one furnish me with a practical recipe for the production of MgS?—W. W.

Dead Oil.—A correspondent wishes to know where this can be obtained.

Cast Porcelain.—In answer to "Silex" (*Am. Repr.*, August, 1863, page 108) I am happy to be able to afford him the information he wants. Some specimens of this material were exhibited before the last meeting of the American Pharmaceutical Association, and the mode of manufacture described. I quote the following from their proceedings:—By a fusion of 1 part of cryolite with from 2 to 4 of pure siliceous, a beautiful glass is formed, susceptible of mould and polish, and capable of being manufactured into an endless variety of useful and ornamental articles, and probably many utensils for chemical and pharmaceutical use will be made of it. A company has been operating in Philadelphia for some time past, on an experimental scale, entitled the "Hot Cast Porcelain Company." The results have been so satisfactory that they have now taken a large establishment, and will be prepared

to carry on the manufacture quite extensively. The cost is, at present, from 10 to 20 per cent higher than ordinary flint glass. The ware seems to be stronger than glass.—PHARMACEUTIST.

ANSWERS TO CORRESPONDENTS.

NOTICE.—The American Publishers of THE CHEMICAL NEWS give notice that in accordance with a suggestion of Mr. CROOKES, the Editor and Proprietor of the English publication, they will be pleased to receive and forward to him in London any scientific publications issued in America, for review—and also any Notes and Queries, Articles, Correspondence, etc., for publication or reply. Their facilities of communication with Mr. CROOKES render this very desirable to all persons in the United States who wish to confer with him. Address.

W. A. TOWNSEND & ADAMS,

434 Broome Street, New York.

X. A. P.—Phosphorus is now generally purified by treating the crude product with sulphuric acid and bichromate of potash. The red phosphorus, it is said, becomes oxidised first, and rises to the surface in the form of a scum, while the pure phosphorus remains perfectly colourless and translucent at the bottom of the vessel.

W. L.—The work shall be sent by post.

Alfred K.—The term antimony-vermillion has been applied to sulphide of antimony, which, under certain conditions of preparation, exhibits a pure red color.

Hardware.—Iron vessels must be used; they are not attacked by strong nitric acid.

Quint Color.—The best book on the subject, with which we are acquainted, is O'Neill's Dictionary of Dyeing and Calico Printing, published by Ireland & Co., Manchester. Messrs. Longmans & Co. have a work on the aniline dyes just ready for publication.

R. E. B.—An Old Subscriber.—Some little time must unavoidably elapse between the delivery and the publication of a lecture, when, as in the instances you refer to, the author himself rewrites the lecture specially for our columns. We imagine that the readers of the CHEMICAL NEWS prefer to wait for a week or two when the advantages to be gained are so great. In scientific lectures a mere shorthand report is not sufficient without the author's corrections.

Z. Z.—For the processes required for the valuation of manganese see the fourth edition of "Fresenius's quantitative analysis," published by Churchill, page 618.

Dead Oil.—A correspondent who wrote about dead oil last week is informed that several communications are waiting for him at our office.

A. Deck.—Medlock's bisulphite of lime solution may be obtained of the manufacturers, Messrs. Bailey and Son, Wolverhampton, or Lawrence Pountney Hill, London, E.C.

Dyeing.—A correspondent who inquires on this subject, but gives no name, is informed that no information on the subject named is at present in our possession.

T. D. Read.—The number of the *Technologist* shall be sent.

A. N.—A sample of benzoic acid is waiting for this correspondent at our office.

Communications have been received from H. Saunders (with enclosure); W. Wallace; J. R. Atkinson; J. Richardson; W. Rose (with enclosure); T. Groves (with enclosure); Kuhlmann & Co.; A. Losh; W. de Castro; Mr. Young (with enclosure); J. Owens; T. Hunt; F. Maxwell Lyte (with enclosure); J. A. Wanklyn; W. F. Barrett (with enclosure); J. S. Bouck; W. Huggon (with enclosure); C. Cochrane (with enclosure); W. Brown; Castle & Lamb; W. Blythe (with enclosure); R. Crook; E. Wheeler, jun.; Dunn & Co.; C. J. De Winton; F. C. Calvert & Co.; R. A. Macfie; W. Woodbury; J. Samuelson; W. White (with enclosure); D. Forbes; A. de Lomonesoff; W. H. James (with enclosure); F. O. Ward; J. N. Yinen; E. E. Bibby; R. Eading; Rev. T. N. Hutchinson (with enclosure); Dr. B. H. Paul (with enclosure); E. Yewdale; J. Storey & Co.; Dr. J. Blythe (with enclosure); J. S. Brazier (with enclosure); Thos. Taylor (with enclosure); P. Squire; F. Ritchie; D. Penney; P. J. Worsley (with enclosure); the London Stereoscopic Company; Archibald, Walker, and Co. (with enclosure); J. Young; M. M. Miller (with enclosure); J. Heywood; H. Porter; G. Bird; C. Greville Williams, F.R.S.; J. Attfield (with enclosure); T. D. Read, Montreal; McDougall Bros.; Dr. Odling, F.R.S.; H. W. Whiteman, U.S.A.; J. A. Wykes; J. Barrow; A. McCulloch (with enclosure); A. Deck; T. Winter; Dr. F. C. Calvert, F.R.S.; H. Seward; F. O. Ward; J. Parnell (with enclosure); Rev. A. Riggs (with enclosure); E. Doby; Cornish Bros.; W. Darling; J. C. Lee (with enclosure); E. Wheeler, jun.; C. J. Eilam (with enclosure); L. Demuth (with enclosure); Sir Charles Taylor; R. Hogg (with enclosure); A. Gow (with enclosure); Dr. Jaeger; J. H. Freeman, F.R.S. (with enclosure); Dr. J. Attfield (with enclosure); Dr. F. A. Genth (with enclosure); G. W. Wigner (with enclosure); Philip Holland (with enclosure); Messrs. Townsend and Adams (with enclosure); Prof. C. W. Eliot; Beer and Co.; F. C. Calvert and Co. (with enclosure); Dr. R. Angus Smith, F.R.S.; Prof. Heaton (with enclosure); Howard Grubb; J. Newlands (with enclosure); Dr. T. Wood (with enclosure); G. A. Keyworth (with enclosure); P. Le Neve Foster; Bradburn and Co.; W. Bailey and Son; J. L. Denman; W. B. Pinman (with enclosure); J. I. Headley; G. Morrison, Tasmania; Capt. W. A. Ross; Cornish Bros.; H. H. Watson; W. Smith.

THE CHEMICAL NEWS.

Vol. III. No. 3. American Reprint.

ON THE
MEASUREMENT OF GASES OVER WATER.

BY PHILIP HOLLAND.

Owing to phenomena of absorption and diffusion, the category which includes gases capable of measurement over water is a small one. The gas the chemist is most frequently called upon to measure in this way is nitrogen, when making a determination by the method of Dumas.

With regard to this process, I believe I may assert that the experience of those who have had occasion to employ it, is that the errors of experiment is one usually on the side of excess, varying from two- to three-tenths of a per cent, and sometimes more. Our handbooks tell us that the chief source of this inaccuracy is to be ascribed, mainly, to the fact that it is almost an impossibility to chase away all air from the tube at the commencement of the operation, which, however, is expelled at its close: that is to say, when the combustion tube has been heated to redness throughout its length. There is, I consider, another source of error of more or less importance, viz., that the analyst is apt to over-estimate the volume of gas when reading off over water. This is more particularly to be feared when wide tubes are used. In order to remove a possible objection of this kind, I would propose the adoption of the little device of Erdmann,—the glass float which we are so frequently in the habit of employing when measuring fluids; the principle of its application is the same in both cases. The measurement of nitrogen would be conducted as follows:—The graduated tube is nearly filled with water, and inverted in a deep glass vessel. The float, which should be of considerably smaller diameter than the interior of the tube, is allowed to ascend into this latter. Air is next admitted in sufficient quantity to cause the float to take up a position with its line opposite a graduation; the tube is then to be completely submerged, so as to bring the volume of confined air to the temperature of the water. In this state it is to remain whilst the nitrogen is being collected over a solution of potassa. When the combustion is terminated the attention is directed to the measuring tube, which must be raised by means of a wooden holder until the level of the water inside and outside is equal. The graduation must then be read off by means of the float and the number noted; it now remains to transfer the nitrogen in a suitable manner, again to submerge, and note finally the difference of volume.

This difference represents the volume of nitrogen furnished by the substance burnt, and is the one to which the necessary corrections for temperature and atmospheric pressure are to be applied. As regards the complete expulsion of the air from the combustion tube at the commencement of the analysis, I found that a series of experiments made some time ago, in which I took about an equal volume of oxide of copper in each case, gave rather more than a cubic centimetre of unabsorbed gas. A single experiment, made a few days since, gave 1.3 c.c. It was conducted as follows:—Into a tube of the usual length, sealed at one end, was put sufficient dry bicarbonate of soda to fill a space of 6 inches; this was followed by freshly ignited

oxide to within 4 inches of the open extremity. A cork and delivery tube were next attached, and the combustion tube placed in the furnace; air was expelled by heating the sealed extremity for some minutes. When the tube was judged to be free from air, the curved end of the delivery tube was passed under the mouth of a cylinder containing a strong solution of potassa, through which the gas was allowed to pass for 15 minutes; at the end of that time the bubble of unabsorbed gas was almost unappreciable. Heat was next applied to the anterior part of the tube, and thence along its whole length. The bubble of unabsorbed gas was measured in a narrow tube over water by means of a float; its volume was found to be 1.3 c.c.

This experiment appears to show that oxide of copper imprisons air between its particles in the process of filling, which is not exchanged for carbonic acid until the oxide is heated to redness. Thinking, therefore, some advantage could be gained by replacing the air originally in the tube by dry carbonic acid previous to filling, the last experiment was repeated with that difference in the conditions. I found, as a result, an advantage as regards the time which elapses before the gas is sufficiently pure to be absorbed by the potassa, but I did not observe any marked reduction in the volume of the bubble.

ON THE
SPECTRUM OF POTASSIUM AND OF BARIUM.

BY J. H. FREEMAN, F.C.S.

Of the seventeen lines which constitute the most characteristic part of the Potassium Spectrum, some make their appearance at a lower temperature than others. Now, if a mixture of 10 eqs. of potassic nitrate, 10 eqs. of sulphur, and 3 eqs. of charcoal be ignited, and the light produced analysed by a spectroscope, it will be found that the double line at 130 on Bunsen and Kirchhoff's scale, the line at 430, the triple line at 1120, and the line at 3160 will be visible; whilst the triple line at 1300, the triple line at 1530, the triple line at 1760, and the line in the blue will be invisible. But if in the mixture we substitute potassic chlorate for the potassic nitrate, it will be found that all the lines, with the exception of the one in the blue, will come into view. But it is well known that the temperature produced during the combustion of KClO_3 and sulphur, is much higher than the temperature of the combustion of KNO_3 and sulphur; and a gradual increase of temperature from that produced by KNO_3 and sulphur, up to that produced by KClO_3 , may be obtained by gradually abstracting the KNO_3 and supplying KClO_3 in its place; so that by gradually increasing the temperature of the combustion, it was found that the order in which the lines made their appearance was,—1st, the line at 130, the line at 430, the triple line at 1120, and the line at 3160; 2nd, the triple line at 1530; 3rd, the triple line at 1300; 4th, the triple line at 1760; but the line in the blue remained invisible when the whole of KNO_3 was abstracted, and its place supplied by KClO_3 .

The Spectrum of Barium. If a mixture of 10 eqs. of KNO_3 , 20 eqs. of sulphur, 3 eqs. of charcoal, and 1 eq. of baric chloride be burnt and the light examined, it will be found that none of the lines of the Barium Spectrum will make their appearance. But when a mixture the same as the one just mentioned, excepting that instead of 10 eqs. of KNO_3 there were 9 eqs. of KNO_3 , and 1 eq. of KClO_3 , was burnt and the light examined, the

sharp line at 1330 was visible; but no other. After this a mixture of 8 eqs. of KNO_3 and 2 eqs. of KClO_4 , with the 20 eqs. of sulphur, 3 eqs. of charcoal, and 1 eq. of baric chloride was burnt, and the line at 1620 and the line at 1730 made their appearance. By gradually increasing the temperature in the way already mentioned, it was found that the order in which the lines made their appearance was—

Line at	Line at
1330.....1st	1840.....7th
1730.....2nd	830.....7th
1620.....2nd	990.....9th
1780.....4th	910.....10th
1670.....5th	750.....11th
1530.....5th	1920.....12th

Some of these so-called lines are really bands, and when this is the case the central part of the band is referred to on the scale. The spectroscopic used had a prism of dense flint glass, with an angle of 60° ; and a telescope with a magnifying power of seven diameters. The breadth of the slit was about .09 millimetre.

WRITING ON A SCREEN.

BY PROF. ALBERT R. LEEDS,
OF HAVESFORD COLLEGE, PA.

EVERY lecturer has felt how unsatisfactory it is to write or draw, or in any manner attempt to illustrate his ideas in a large room. This difficulty may be overcome in the following manner:—A plate of glass is placed in the lime-light or magnesium lantern, and an inverting prism put in the forward part of the draw-tube of the objective. If now, while looking and lecturing to the audience, writing is done with an ordinary pen and indian-ink upon the glass plate, and proceeding from left to right upon the plate, it will advance correspondingly upon the screen, and will be read in greatly enlarged characters by those present. The square prism inverts with respect to bottom, and the writing being actually reversed by the writer in reference to the other direction in which the lantern is pointing, the crossing of the rays produced by the lens becomes in this case an advantage, and corrects the letters upon the screen. A collodion film, blackened by exposure to the sun's rays, may be substituted for the naked glass plate to great advantage. On such a film chemical and mathematical formulae, drawings of apparatus, machinery, crystals, anatomical delineations, &c., may be cut with the utmost delicacy, and appear as intensely bright white lines on a black ground, and with something of the appearance of an immense copper-plate engraving.—*Am. Journ. Sci.*, May, 1868.

ON SUPERSATURATED SALINE SOLUTIONS.

BY CHARLES TOMLINSON, F.R.S.

THE phenomena presented by supersaturated solutions are of a perplexing character, and have occupied the attention of many inquirers during the last seventy or eighty years. The fundamental fact on which the subject rests is sufficiently remarkable, namely, that a strong, hot solution of a salt such as that of sodic sulphate, which, in cooling in an open vessel, soon begins to deposit crystals, should, in a closed vessel, retain the salt in solution at ordinary atmospheric temperatures, and so become supersaturated, that is, capable of holding a much larger quantity of salt than the water could

take up at the reduced temperature. Gay-Lussac referred the state of supersaturation to the inertia of the saline molecules, as well as to the molecular condition of the sides of the vessel. Löwel, after an elaborate inquiry extending over many years, arrived at the conclusion that the state of supersaturation is one in appearance only, and not in fact; that a solution of the ordinary decahydrated sodic sulphate, for example, saturated at the boiling point, and cooling down in a closed vessel to about 60°F. , changes its molecular condition into one of a more soluble salt, namely, the heptahydrate; that on a further reduction of temperature, crystals of the modified, or seven-watered salt, are deposited at the bottom of the solution. If, however, the vessel be opened, or the solution touched with an active nucleus, it instantly recovers the molecular condition of the ten-watered salt and becomes solid. As to the action of the air and other nuclei, Löwel regards it as "the effect of one of those mysterious contact actions, known as *catalytic*, of which science has not yet been able to give a satisfactory explanation."

Löwel's theory, respecting the molecular change of the solution and the increased solubility of the modified salt, has been generally accepted as a satisfactory explanation of the existence of supersaturated solutions. Such being the case, later inquirers have chiefly directed their attention to the action of nuclei. We have noticed their researches on several occasions. M. Gernez,* for example, examined not fewer than 220 substances in his endeavour to find some law of action for nuclei. He also extended his researches to supersaturated gaseous solutions,† such as soda water, champagne, &c. His explanation of the latter class of phenomena was combated by Mr. Tomlinson,‡ who started a new theory and supported it by a number of decisive experiments. In a paper read before the Royal Society, on the 28th of May last,§ Mr. Tomlinson amplifies and extends this theory to supersaturated saline solutions. He also combats Löwel's views as to the molecular change that leads to the formation of a more soluble modified salt, and substitutes an entirely new theory, supported by experiments, to account for the formation of the modified salt.

We propose to give a short account of Mr. Tomlinson's theory, if it is possible to be shorter than the necessarily brief abstract published in the Proceedings.

As to the action of solids as nuclei, Mr. Tomlinson distinguishes between those that are chemically clean and those that are not clean, or only clean in the ordinary sense of the word. If a vessel containing a supersaturated solution, say of Glauber salt or of Epsom salts, be made chemically clean by a previous washing in strong sulphuric acid, or in spirits of wine, or in caustic alkali, the solution adheres to it as a whole, and there is no separation of the salt at ordinary temperatures. So, also, if a glass rod, or other solid nucleus, be made chemically clean and placed in the solution, there is the same perfect adhesion between it and the solution, and it does not produce any separation of the salt. If, however, the interior of the vessel or the glass rod be not chemically clean, there is a stronger adhesion between the salt and the unclean surface than between the water of the solution and the salt, or between the water of the solution and such surface, and there will be a separation of the salt; and the action thus once begun

* See CHEMICAL NEWS, xi, 250, 289 (Eng. Ed.).

† *Ibid.* xiv, 260 (Eng. Ed.).

‡ *Ibid.* xvi, 54, 149 (Eng. Ed.).

§ Proceedings of the Royal Society, xvi, 403.]

will be propagated rapidly throughout the liquid until, in strong solutions, the whole becomes solid. In such a case the rise in temperature may be considerable; in the case of the sodic acetate it was as much as 90° or 100° F.

It is remarkable that if strict attention be paid to chemical purity, highly charged supersaturated solutions, including that of the sodic sulphate, may be cooled down to 10° F., or lower, without any separation of the salt. Hence Mr. Tomlinson denies that any molecular change takes place in the solution of sodic sulphate when the temperature falls below 60°, as Löwel supposed. Many of Löwel's results were probably due to want of purity in the sides of his vessels, and to his practice of closing his flasks with corks, instead of simply plugging them with cotton wool. When corks are used a rarefied atmosphere is formed above the solution during the cooling, and the air often finds its way in, dragging with it a solid mote or particle of dust, which acts as a nucleus; whereas, with a cotton wool plug, the air retains admission as the solution cools, and the wool keeps back dust and motes. The air itself is not a nucleus, for a solution in a clean stoppered bottle, only one-third or one-half full, may be violently shaken, and the air thoroughly incorporated with the solution, without any separation of salt; but when the stopper is removed, the solution immediately becomes solid. Hence, when air appears to act as a nucleus, it is only as a carrier of some mote or particle of dust that acts as a nucleus; and this explains the curious facts, observed by previous enquirers, that supersaturated solutions can be kept longest in narrow-necked open vessels than in wide ones, because in the one there is less chance of a mote falling in than in the other. When a solution does not crystallise on taking out the plug, it may often be started by scratching the inside with a wire not chemically clean (if chemically clean it will produce no effect). The lines scratched on the interior of the flask, though invisible at first, are chemically unclean, and are immediately filled up with minute crystals, and the action, once started, continues. So, also, if a strong and hot solution be filtered into a chemically clean flask, and, before closing it, the upper part of the inside be touched with the finger slightly greasy, the solution will cool down and remain supersaturated; but if the flask be inclined, so as to touch the unclean portion, crystallisation immediately sets in.

A liquid, such as spirits of wine, acts as a nucleus indirectly, by combining with a portion of the water of the solution, and setting free a portion of the salt. This starts the crystallisation, and the action, once begun, continues. Hence, in many cases of supersaturated solutions prepared with distilled water, boiled and carefully filtered into chemically clean vessels, there is nothing to start crystallisation, and such solutions may be kept any length of time, or even put into freezing mixtures at 10° F., or from that to 0°, without any separation of the salt. Supersaturated solutions of the sodic sulphate, acetate, arseniate, succinate, and borate were treated in this way; as also of Rochelle salt, potash alum, Epsom salts, and some others. In other cases the supersaturated solutions, at low temperatures, suddenly solidified, as in the case of the sodic carbonate and phosphate, the plumbic acetate, and some others. Other solutions deposit their excess of salt at low temperatures, or under the action of a nucleus, leaving the mother liquor saturated; such are the zinco-acetate, the cupric sulphate, baric chloride, citric acid, and some others.

Seeing then that many highly charged supersaturated solutions,* if proper precautions be taken to insure chemical purity, can be reduced to low temperatures without crystallising, Mr. Tomlinson contends that supersaturation exists in fact, as well as in appearance, and that there is no proof of any molecular change in such solutions, such as to lead to the formation of a more soluble salt which forms only a saturated solution on account of its greater solubility. Such a view of the case is mere theory unsupported by experiment. But then it may be asked, "How does Mr. Tomlinson account for the seven-atom hydrate in the case of the sodic sulphate, and which is found only in supersaturated solutions?"

The answer to this question is stated very clearly. The ordinary sodic sulphate, which crystallises with ten atoms of water, parts with this water so easily by mere exposure to the air or under a gentle heat, that there can be no doubt that when placed in hot water, it is the anhydrous salt that enters into solution. Now when such a solution (2 salt to 1 water) is reduced to a temperature sufficiently low, it deposits a portion of the salt it can no longer hold at the reduced temperature. But the salt thus deposited is not the ten-atom hydrate, nor the seven-atom hydrate, but it is the anhydrous salt in octahedral crystals, the hydrates being in prisms, the one with dihedral and the other with oblique summits. Now if the tube be set aside or even be left in the freezing mixture, as the temperature rises these anhydrous crystals enter into solution and form a dense lower stratum, containing only water enough for the seven-atom hydrate, and accordingly this salt forms at the bottom of the vessel in small quantity, while the remainder of the solution that rests upon it is still supersaturated. If now the tube be opened, crystallisation will set in from the surface, where there is plenty of water, and the crystals dart rapidly down, carrying with them, not only enough water to form the ten-atom hydrate, but also enough to convert the seven-atom into the ten-atom hydrate, a change which is marked by the dead white opacity that comes over the modified salt.

The formation of the modified salt may be conveniently studied in the case of zinco-sulphate. When a saturated solution of this salt cools down from the boiling point to about 70°, an anhydrous or monohydrated salt is thrown down in quantity, and as the solution cools a portion of this dissolves, and a crop of acicular crystals is produced. This is a modified salt formed at the bottom, very different from the ordinary six-atom hydrate which forms at the surface as soon as the plug is removed. The ammonia-phosphate also forms a modified salt. The strontia nitrate also deposits an anhydrous salt in cooling down to about 62°; but as this is not soluble in the solution, the modified salt is not produced.

M. Löwel points out modified salts in the case of the sodic carbonate and the magnesia sulphate; but as he attaches great importance to the peculiar catalytic properties of the sides of his vessels in determining the formation of these salts, Mr. Tomlinson supposes M. Löwel's results were due to portions of the sides of his vessels, not chemically clean, acting as nuclei. In chemically clean vessels M. Löwel's results were not

* Some idea may be formed of the extent of supersaturation from the fact stated by Mr. Tomlinson in the discussion on his paper, that some solutions at low temperatures contain from 60 to 90 times more salt than the water could take up at those temperatures, and that without any separation of the salt.

produced. The sodic carbonate solution suddenly became solid in reducing the temperature; while the magnesia sulphate solution resisted a cold of 10° F. and under.

The conclusions arrived at by Mr. Tomlinson are—(1), that a number of hydrated salts form supersaturated solutions and remain so even at low temperatures simply from the absence of a nucleus to start the crystallisation. (2) That a nucleus is a body that has a stronger adhesion for the salt than for the water which holds the salt in solution, a state of things brought about by the absence of chemical purity. (3) That three or four salts form supersaturated solutions which in cooling down deposit a modified salt or one of a lower degree of hydration than the normal salts. (4) That this modified salt is formed first by the deposit, in small quantity, of the anhydrous salt, which entering into solution, forms a dense lower stratum containing less water than the rest of the solution, in which lower stratum the modified salt is formed. (5) That salts of a low degree of hydration form supersaturated solutions, which on reduction of temperature, or, by the action of a nucleus, deposit the excess of salt that held the solutions supersaturated, leaving them merely saturated.

We venture to think that if these conclusions are substantiated, the whole subject of supersaturation is definitely settled.

It has often been stated that certain anhydrous salts, such as nitre and potassic bichromate, form supersaturated solutions. Mr. Tomlinson arrives at an opposite conclusion. His method of testing this point was to make a solution of known strength as indicated by some good Table of solubilities, raise it to the boiling point, and then note whether any salt was thrown down when the solution reached the temperature indicated by the table. Thus, according to Gay-Lussac's table, 100 parts of water at 150° F. contain in a saturated solution, 125 of potassic nitrate. A solution of 125 parts salt in 100 of water, in a chemically clean flask, with a clean thermometer passing through the cotton wool plug, sank from the boiling point to 149° , when it began to deposit salt. The deposit first appeared on the side nearest the window, or the coldest side, when the flask was suspended in air; but if the flask were placed on metal or other good conductor, a ring of salt was first formed at the bottom 6° or 8° earlier than when the flask stood on a block of wood.

According to Kremer 200 of water at 140° F. dissolve 100 parts of potassic bichromate. Such a solution in cooling from the boiling point began to throw down crystalline flakes at 138° .

Many other solutions were tried, and the conclusion is that anhydrous salts do not form supersaturated solutions.

ON A NEW AMMONIATED CHLORIDE OF ZINC.

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In an investigation (still in progress) of what appears to be a new class of zinc compounds, I found it desirable to make myself familiar with the ammoniated chlorides of zinc. Three of these have been described by Sir Robert Kane, namely, a monammoniated, diammoniated, and a tetrammoniated zinc chloride, zinc being treated as diatomic. I have obtained another, a

pentammoniated chloride. To obtain it, solid zinc chloride is dissolved in the strong solution of ammonia of commerce, and as the solution of the first portions of chloride is attended with a marked rise of temperature, it is advisable to add the salt gradually, to close the vessel tightly to prevent expulsion of the ammonia, and to cool the vessel by a stream of cold water. When the solution of the zinc chloride becomes exceedingly slow, ammonia gas is passed into the liquid. If this is kept cool a crystalline precipitate soon forms; if, on the contrary, the liquid is not kept cool by the application of external cold, the liquid usually remains clear for some time. When the liquid in the cold state contains a moderate amount of deposit, the passage of ammonia into it must be stopped; then on closing the vessel containing it, and heating gently and shaking, the crystalline deposit may be redissolved. On cooling, the solution gradually yields the new chloride in large crystals of remarkable appearance. They are regular octohedra, with perfect angles and edges, but with deficient faces; that is to say, the faces are hollowed out in a series of steps from the edges to the centre of the face, so as to exhibit a structure similar to that seen in the hollow pyramidal crystallisations of sodic chloride. The mode in which such crystallisations of sodic chloride are produced is well known to be the formation of a small cube of the salt at the surface of the brine, to which it adheres by one of its faces, causing a depression in the fluid surface because of its density, and then the gradual addition to the upper external edges of the crystallisation of successive square courses of the sodic chloride. The formation of the hollow faces of the octohedra of the new ammoniated chloride of zinc is apparently partly similar to this—comparatively large crystals sometimes hanging from the surface of the mother liquor by a hollow face. But then all the faces of these octohedra are thus hollowed out so that their formation can have no necessary connection with crystallisation at the surface of the fluid; and to make the crystals of sodic chloride similar in their hollowed form to these octohedra, the cubical piece at the apex of the pyramid would have to be the centre and common apex of six such pyramids united in the form of a cubical flock with hollowed faces.

The crystals of this ammoniated zinc chloride give rise by their shape to a lively display of the prismatic colours while they remain immersed in their mother liquor, and are further distinguished from most crystalline bodies by being almost non-adherent to the vessel in which they form, and to each other, rolling about as the vessel is inclined. I have mentioned that the crystals are large. I may add in illustration that the largest of those formed in a night in about 50 cubic centimetres of liquor, and perfect of its kind, measured 8 m.m. in the edge. Exposed to the air they evolve ammonia, lose their lustre and transparency, and become eroded, thus indicating, perhaps, a composite structure. The eroding agent is undoubtedly the mother liquor which adheres to them when they are taken out of it, for this, by losing some of its ammonia, at once becomes a powerful solvent of them, as is shown in another way as follows:—If to the ammoniacal liquid filled with these crystals some solid zinc chloride be added, both it and the crystals dissolve, even if these are in such quantity as to make the whole semi-solid, the zinc chloride added combining with some of the ammonia of the ammoniated zinc chloride. The crystals attract moisture from the atmosphere as well as

evolve ammonia,—at first losing weight and then increasing till they exceed their first weight, and at the same time partially liquefying. Whether the undecomposed salt is deliquescent it seems hardly possible to determine. They dissolve very rapidly in water, forming a clear solution till largely diluted. The results obtained by the analysis of this chloride are quite sufficient to determine its composition, but it was found to be very difficult to prepare it for examination because of its instability. The crystals were removed from their mother liquor, and, without washing, dried as rapidly as possible between folds of bibulous paper. One sample gave the following:—269 grammes distilled with potash gave a distillate which showed by its neutralising power the presence of '09435 gramme ammonia. '2372 gramme dissolved in nitric acid, and neutralised, indicated, with a volumetric solution of silver, the presence of '07318 gramme chlorine. Another sample dried with great rapidity, and imperfectly, gave the following results:—'7769 gramme gave by the volumetric method '27557 gramme ammonia. '22215 gramme indicated by the volumetric solution of silver the presence of '06534 gramme of chlorine. The substance is therefore the pentammoniated zinc chloride $\text{ZnCl}_5(\text{NH}_3)_5 \cdot \text{H}_2\text{O}$.

	First Sample.		Second Sample.		
	I.	II.	III.	IV.	Calculated.
Ammonia	35'07		35'47		35'57
Chlorine		30'85		29'41	29'68

I believe that I have also obtained a hexammoniated zinc chloride; but the difficulty of preparing it for analysis prevents me from being able to speak positively at present.

ON THE RATE AT WHICH CHEMICAL ACTIONS TAKE PLACE.

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THE science of Chemistry may be defined as the science which investigates the relations of the different kinds of matter one to another. The conception of different kinds of matter—each of which has its particular character, its own colour and crystalline form, its own hardness and brittleness, or the reverse, its own conducting powers, its own specific heat and specific gravity, and many other peculiarities of its own, and each of which is homogeneous, the smallest particle having all these properties equally with the largest mass—is the fundamental conception of chemistry.

And the whole world to a chemist is only a mixture of such different kinds of matter, whose mode of aggregation has been and is being determined by physical and vital forces which are foreign to his science, but whose resemblances and differences, and whose changes under changed conditions, or by contact one with another, form the subject of his study.

In the study of any chemical change there are two things to be discovered: first, the *result* of the change—what kinds of matter have ceased to exist and what have come into existence; and, secondly, the *course* of the change; as to which such inquiries as the following present themselves—at what rate does the change occur, and under what conditions? Is it simple, or does it consist of several changes? Are these dependent or independent, successive or simultaneous?—with many

others of a more hypothetical kind as to the molecular nature of the change. A familiar example of this two-fold nature of chemical inquiry may be drawn from the case of a fire, a chemical change which has been more watched than any other. We know all that is to be known as to the result of the change, when we have discovered that the coals are a mixture of various hydrocarbons with a small quantity of metallic salts, that the air is a mixture of oxygen and nitrogen, and that when the fire has burnt out, there exists, instead of so much coal and so much air, a quantity of carbonic acid and water, the salts, which form the ash, and the nitrogen remaining mainly as they were. But there is still much besides this to be found out as to the burning of the fire. How, for example, is the rate at which it burns affected by the draught, or by the density of the air, or by the breaking up of the fuel, or by access of the sun's rays? What are the substances formed from the heated coal which actually burn? Does the reduction of the products of combustion by carbon play an important part in the phenomenon? Such questions as these relate to the course of the chemical change.

The two lines of inquiry thus indicated have been pursued with very unequal vigour. The study of the results of chemical action has engrossed the attention of chemists almost to the exclusion of the study of their course. And, indeed, so great is the number of different kinds of matter, all capable of undergoing a multitude of changes by the action of heat or electricity, or, by contact with others, giving rise thus to new kinds of matter capable of similar changes, that this part of the science appears absolutely boundless. The direction which chemistry has taken in consequence of this superabundance of materials may, perhaps, be contrasted with that taken by physical science. If the number of distinct physical forces met with in nature, such as gravity, magnetism, electricity, heat, light, &c., instead of being quite a small number, had been a large number, and these forces had proved to be convertible not only one into another, but into an infinite variety of other distinct forces, physical experimentalists might have occupied themselves wholly with establishing the transmutations of one kind of force into another and creating new modes of force, instead of studying minutely, as they have done, the conditions under which the existing forces are produced, and the laws which govern their distribution and transformation.

It is, however, not only the vastness of the chemical field, and the particular satisfaction which so solid a result as the creation of a new kind of matter brings to the mind of the investigator, which has led to the neglect of the study of the course of chemical changes. This study is beset with peculiar difficulties, and indeed, out of the vast number of chemical changes whose results are known, there are but very few whose course can readily be observed. The principal reason of this is the velocity with which such changes take place; and this velocity is apt to be the greatest in the case of the simple chemical actions which are most suitable for investigation. Either, then, we must contrive some mode of estimating a very great velocity, as has been done for the measurement of the rate at which light and electricity travel, or we must select a change—and this the variety of chemistry makes possible—which proceeds at a rate convenient for observation.

Examples of the different velocity of chemical changes are furnished by the precipitation of a barium and

of a calcium salt from their solutions upon the addition of a sulphate. With the former, the change is apparently instantaneous. The result is known, but the course cannot be observed. With the latter the change is gradual, and it would be possible to determine its rate at different temperatures and with different quantities of the two salts in solution.

The decomposition of a hyposulphite in an acid solution is another example of a gradual, observable change.

We may compare, also, the reduction of a chromate by a sulphite and by an oxalate. The former occupies no appreciable time; the actual time is, doubtless, greater in a more dilute solution and at a lower temperature, but we cannot discern any difference. But with an oxalate for reducing agent, though the final result of the change is the same, the action takes a long time to accomplish itself, and it would be quite practicable to observe in what way different circumstances affect its rate.

But in order to discover the laws which govern the rate of any chemical change, some exact mode of measuring the rate is necessary. It remains to show how this may be accomplished in certain cases.

A solution of ammonium nitrite, heated to a temperature of about 80° C. in a flask provided with a gas delivery tube, gives off a quantity of nitrogen, which may be collected over the pneumatic trough. By keeping the temperature constant, and collecting the gas evolved during successive equal intervals of time in similar cylinders, it is possible at once to show the regular diminution in the volume of gas which is caused by the constant diminution of the quantity of salt in solution. And by making the experiment and measuring the quantities of gas with accuracy, it would be possible to discover the relation between the amount of change going on at any moment, and the amount of salt in solution, and also, by making the experiment at different temperatures, to discover how the temperature of the solution affects the rate at which the action takes place.

The reduction of a permanganate by an oxalate in an acid solution furnishes another case of a gradual measurable change, and has been more fully studied. Here it is possible to start the change at any moment by adding the measured quantity of permanganate to the other ingredients, and mixing rapidly. It is also possible to stop it at any moment by adding a solution of iodide to the mixture; and the iodine which is set free by the action of the residual permanganate corresponds to it in quantity and can readily be estimated. By making a number of such experiments, differing from one another only in the time during which the gradual change is allowed to proceed, its course may be traced throughout with any required degree of minuteness. The results obtained in any series of such experiments are given in the "Philosophical Transactions for 1866," p. 206. The general conclusion to which they lead is that the total amount of change occurring at any moment is directly proportional, all other conditions being alike, to the amount of permanganate in the solution.

The last chemical change which has been investigated from this point of view, is that which takes place when dilute acid solutions of an iodide and a dioxide, such as barium or sodium dioxide, are mixed together. By arranging suitably the dilution, acidity, and temperature of the solution, the change may be made to proceed at any rate that is most convenient for measurement. One of the products of the change is iodine, a substance for which we have, in its action on starch,

a most delicate test. By bringing a small known quantity of hyposulphite into the liquid all the iodine that is formed by the gradual reaction of peroxide and iodide is reconverted into iodide, and this continues till iodine enough has been formed to remove all the hyposulphite. As soon as the last particle of hyposulphite has been removed (converted into tetrathionate), free iodine appears in the solution, and the moment of its appearance may be noted by carefully watching the colour of the liquid. By adding successive quantities of hyposulphite, and observing the interval which elapses between successive reappearances of the blue colour of the iodide of starch, it is possible accurately to determine the rate at which the change is proceeding. An account of a number of experiments made in this way, and of their results, is to be found in the "Philosophical Transactions of 1867," p. 117. Each set of observations determines at what rate the dioxide is reduced, under certain conditions; and by making different series of experiments, in which the several conditions affecting the rate of change are systematically varied, it is possible to discover the laws of connection between each of the conditions and the amount of change. Having discovered these laws, our knowledge of the change is so far complete, and we can predict with certainty the time that would be required for any given amount of change under any given circumstances.

The following propositions embody the principal conclusions to which the examination of these cases of gradual chemical change has led:—

1. The rate at which a chemical change proceeds is constant under constant conditions, and is independent of the time that has elapsed since the change commenced.
2. When any substance is undergoing a chemical change, of which no condition varies, excepting the diminution of the changing substance, the amount of change occurring at any moment is directly proportional to the quantity of the substance.
3. When two or more substances act upon one another, the amount of action at any moment is directly proportional to the quantity of each of the substances.
4. When the rate of any chemical change is affected by the presence of a substance which itself takes no part in the change, the acceleration or retardation produced is directly proportional to the quantity of the substance.
5. The relation between the rate of a chemical change occurring in a solution, and the temperature of the solution, is such, that for every additional degree the number expressing the rate is to be multiplied by a constant quantity.—*Proceedings of the Royal Institution.*

ON THE ESTIMATION OF SULPHUR IN IRON OR MINERALS BY MEANS OF A PLATE OF SILVER.

BY M. W. EGGERTZ,

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1. Iron.

0.1 gramme of cast iron, wrought iron, or steel cut up or pulverised, and passed through a sieve with holes not larger than 0.6 m.m., is introduced by means of a

glass or glazed paper funnel, into a flask about 0.15 metre high and 5 centimetres diameter, previously containing 1 grm. of water and 0.5 grm. of concentrated sulphuric acid, or in preference 1.5 grm. of sulphuric acid, sp. gr. 1.25, and whose volume (1.5 c.c.) has been marked on the flask.

A piece of polished silver plate (18 m.m. long, 7.5 m.m. wide, and 1 m.m. thick, with a hole at one end), composed of 75 per cent of silver, 25 per cent of copper, and attached to a thin platinum or silver wire, is quickly introduced into the flask, so that it may be a little below the neck; a cork is put in so as to hold the wire without completely closing it. It is allowed to stand fifteen minutes at the ordinary temperature, and the silver plate is then removed.

If the iron contains sulphur the plate is coloured by the sulphuretted hydrogen gas disengaged during the solution of the iron in the dilute sulphuric acid; and, according to the amount of sulphur present,* the colouration of the plate passes to a coppery yellow, a bronze brown, a bluish brown, or a blue. These colourations are determined with the greatest accuracy, especially that of the silver plate alone No. 1, that of coppery yellow No. 2, that of bronze brown No. 3, that of blue No. 4. The intermediate degrees may be represented by decimals thus: 2.5 if the colouration is between 2 and 3; 3.1 if the plate is one-tenth towards the blue; 3.5 if it is as much blue as brown; 3.9 if the brown colouration is feeble.

As the normal colouration No. 2, we have adopted that of the bronze called yellow metal, newly rubbed with fine sand on leather (this metal consists of 60 parts of copper and 40 of tin). For the colouration No. 3, we have not been able to find a convenient alloy. A bronze, consisting of 85 parts of copper and 15 parts of zinc, does not quite represent the colour which should be obtained, for when freshly cleaned it is too bright, and at last takes a bluish colouration. For the colour in question it is better to use a plate of silver which remains in the flask during the solution of the iron, until it has become as brown as possible, and a slight bluish colour begins to be perceived; the plate is then removed and preserved in a well closed tube. The colour No. 4 resembles that of a watch spring. If the amount of sulphur is very considerable, this colouration passes to a clear bluish grey. By passing the plate of silver over a bottle of sulphide of ammonium the desired number can be easily obtained.

To obtain in these assays for sulphur, the proper tint on the silver plate, it is necessary to take certain precautions. The plate is to be held in pincers and cleaned as well as possible by rubbing it with a soft leather in which is placed a little very fine rotten stone. Contact with the fingers is avoided by means of a piece of paper, and the plate is to be carefully dried with a piece of filtering paper. If the plate, by bleaching or by the action of the burnisher, has been purified on its surface, this should be carefully removed by again rubbing with the leather, for pure silver is less sensitive to the action of the gas than that of the given standard. Thus it has sometimes been found that the silver employed for coinage furnishes less homogeneous plates, of which those parts richest in copper assume more quickly the blue colouration. On this account, the plates should be compared between themselves, by introducing them at the end of a wire into a flask

in which is dissolving iron, containing from 0.05 to 0.08 per cent of sulphur. On introducing the plate, care must be taken not to turn the side but the edge against the strongest current of gas which would otherwise colour one face of the plate stronger than the other. The plate should be rapidly introduced into the flask after the introduction of the iron, as then a very strong disengagement of sulphuretted hydrogen immediately takes place. After a first experiment the flask is to be filled with water several times, so as to get rid of the odour of sulphuretted hydrogen. If a steel mortar is employed to pulverise the iron, the whole of the piece selected should be reduced to very fine powder. The mortar should be well cleaned each time, taking care to remove the disc from the bottom. Also the cloth, plates, and leather should be very clean; if the leather is not clean enough, the silver plate should be passed several times over a filter paper placed over the leather with a small quantity of rotten stone.

The changes in temperature between 15° and 25° C., seem to have no sensible influence on the colouration of the metal; if the temperature exceeds 40° the plate becomes moist and gives false indications.

Many experiments have been made on the white and the grey portions of cast iron; but when made separately these experiments have yielded identical results, although the metal dissolves in unequal quantities. If there is any difference it is that the white iron, being more difficult to dissolve, colours the plate a little more feebly.

There is no doubt that some practice is required to judge of the colouration of the plate, but it may be easily acquired. Generally the best plan is to place the standard plates of tints 1, 2, 3, &c., on a sheet of white paper by the side of the plate under experiment, exposing them to a good light near a window (but not sunlight), and to examine them with a lens. The colourations between 2 and 4 are the most difficult to recognise; but with a little experience none will vary more than 0.1, so that, for instance, the colouration may be valued between 3.5 and 3.6.

The following is somewhat an approximation between the different colourations upon the silver plate and the amount of sulphur as determined by my former process* in a great number of different irons:—

Number of the Colouration.	Percentage of Sulphur.
1.0	0.00
1.2	0.01
2.0	0.02
2.5	0.03
3.0	0.04
3.1	0.05
3.2	0.06
3.3	0.07
3.5	0.08
3.6	0.09
3.7	0.10
3.8	0.12
3.9	0.15
4.0	0.20

It is evident that in this way the exact quantity of the sulphur is not determined; but several years' experience have shown that if these experiments are made with care, and the quantity of sulphur does not exceed 0.1 per cent, the results are near enough for all practical purposes. Iron which does not colour the

* Selenium, when fused with iron, also gives a bluish colouration to the silver plate. Arsenic, antimony, and phosphorus in iron exert no influence in these experiments.

* See CHEMICAL NEWS, vol. 17, p. 231 (Am. Repr., Aug. '68, page 80).

silver plate will sometimes produce a colouration if we double the quantities of iron and acid. With half the quantities of acid and sulphurous iron, silver generally gives a little more than half the real quantity of the sulphur which is present. The sensitiveness of the silver plate may be augmented by moistening it with a solution of carbonate of ammonia, but the colouration becomes very unequal.

Amongst experiments on the estimation of sulphur in iron, the following deserve mention:—

1. The quantity of sulphur in wrought iron is often so small that it produces no colouration on the silver plate; this iron, therefore, not being red-short, may be employed for all kinds of uses. It must not, however, be forgotten that the quantity of sulphur is not equally distributed throughout a piece of iron, but that it may vary considerably in different places. On experimenting with the turnings obtained from a portion of an iron bar which was visibly red-short, a stronger tint is often obtained on the silver plate than when using other parts of the bar. The fragments obtained from red-short iron in boring a horseshoe does not often give on the silver plate a deeper colouration than 2, and it appears to follow that ordinary wrought iron which contains 0.02 per cent of sulphur in certain parts cannot conveniently be employed for this purpose. If the red-short iron gives to the plate a slighter and more feeble colouration than 2, it may be supposed that the breaking is due less to sulphur than to an insufficient working of the cast iron, the crude pieces in wrought iron entirely free from sulphur often acting as if they were red-short. In general it appears certain that the quantity of sulphur in iron is more injurious when the iron has been badly worked. In a hard iron melted in a steel crucible, we may, in spite of its containing 0.04 per cent of sulphur, make holes like those in a horseshoe without any trace of cracks which may undoubtedly be attributed to the homogeneity and good working of this iron. The quantity of phosphorus was only 0.03 per cent. The lower portion of an English rolled rail, without fault, contained 0.11 per cent of sulphur and 0.3 per cent of phosphorus; a portion was cut off which was so red-short that it could not be made use of.

Can the effects of sulphur and phosphorus in iron neutralise each other, and if so, in what degree? This is an old question which has lately been enquired into, and which deserves serious examination—an examination which will become easier when we have more ready means of estimating the quantity of sulphur and phosphorus in iron.

2. The richness in sulphur of steel of the best quality was, according to experiments made, such that the colourations on the silver plate varied only between 1 and 1.5. As in the case of wrought iron, the quantity of sulphur often varies in different parts of the same piece of steel, and that also appears to be the case in a little less decided manner in fused steel.

3. The quantity of sulphur in cast iron is rarely so little as not to colour the plate. In the greater number of Swedish cast irons, this quantity is such that the silver plate varies in colouration between 2 and 3. In iron for gun castings it is between 3.3 and 3.7, and sometimes more. In cast iron the quantity of sulphur is often distributed unequally; there is generally more on the surface than is met with below.

If the colouration of the silver plate does not exceed 3 we can, according to many experiments, assume that the cast iron refined in the ordinary manner will

not give red-short iron, especially if the refining is done carefully. But as in different methods of refining, different quantities of sulphur may be removed from the iron,* and in general more if the iron results from a light charge of the blast furnace, it cannot be said beforehand that all cast iron which communicates a bluish colouration to the plate will necessarily give red-short iron. It ought to be so, however, with cast iron which colours the plate as deep a blue as that of a watch spring. In cast iron which gives a red-short wrought iron without rendering the silver plate more than brown, it is probable (the iron having been well refined) that the cause is owing to other substances than sulphur, but this occurrence is very rare.

Many circumstances appear to show that the quantity of sulphur in iron diminishes with time, at least on the surface, and under favourable conditions.

II. Iron Minerals.

The quantity of sulphur in a mineral cannot be estimated in the manner just described; all that can be done is to estimate the sulphur in the cast iron, which is obtained by reducing the mineral in a crucible, as described in *Jernkontorets Annalen*, 1851, p. 56. Attention must always be paid to the following:—

A. That the powdered charcoal which fills the crucible is free from sulphur. This is ascertained by fusing iron, as free as possible from sulphur, in a crucible filled with the same powdered charcoal, and then examining the regulus obtained. If this latter gives a higher amount of sulphur than the iron originally contained, the cause is attributable to the charcoal. At Fahlun, the charcoal absorbs, in a short time, much sulphur from the smoke of the pyrites burning; and the powder selected for the crucible experiments in the Mining School is obliged to be kept in closed vessels. If the charcoal employed as a combustible in the crucible furnace is exposed to the action of much sulphuretted hydrogen, or sulphurous acid, the experiments show it.

B. The state of the mineral, whether unroasted, badly roasted, or well roasted. The small laboratory experiments, having for their object to ascertain how much sulphur can be removed from a mineral by roasting in bulk, are always inexact.

C. The influence exerted on the quantity of sulphur by the minerals mixed with it. It follows from many experiments made at the Mining School, that the more silicic acid the slag contains the more sulphur the cast iron receives, and that the quantity of sulphur gradually diminishes in proportion as the quantity of lime is increased.

We may here cite, as an example, the nature of the regulus, according to the mineral with which it has been reduced:—

With 15 per cent of quartz the regulus contained 0.09 per cent.

With 5 per cent of lime, the regulus contained 0.04 per cent.

With 20 per cent of lime, the regulus contained a little more than 0.01 per cent.

The first slag was like enamel, the second was vitreous, and the third waxy. In general, assays for sulphur should be made with regulus obtained from a mixture containing as little lime as possible, but giving vitreous slags. If the colouration of the silver plate does not exceed No. 3, the quantity of sulphur may be

* In the Bessemer process only very little sulphur can be removed.

considered as insignificant, especially in experimenting on non-roasted minerals.

The lime used in blast furnaces may be assayed for sulphur in the following manner:—

Mix 0.8 gramme of rich and pure iron mineral with 0.2 gramme of quartz and 0.2 gramme of lime; fuse the mixture as usual in a crucible, and assay the resulting iron for sulphur. In this manner it may be ascertained if the lime contains an injurious dose of sulphur. If it were chemically pure we should obtain, by the addition of 2 or 3 per cent of clay or talc, free from sulphuric acid, a better slag. If, on the contrary, the lime contains much silicic acid, more than 0.2 gramme should be taken for the experiment.

EXPERIMENTS WITH COMMERCIAL ROSOLIC ACID, SO-CALLED AURINE CAKE.

BY A. ADRIANI, M.D., PH.D., ETU.

My attention having been casually attracted to aurine cake, I felt induced to make some experiments with it in order to find out whether it would be possible to obtain from this material, pigments fit to be used as oil paints, chiefly for artists' use. None of the pigments I have obtained will answer for this purpose at all, since, on being mixed with even very clear linseed, nut, or poppy-seed oil, the colours originally exhibited by the divers dry pigments, to be described hereafter, all change to very indifferent shades of dark stone-red colour, somewhat similar to oxide of iron paint.

I think it may not be quite superfluous to your readers to briefly enumerate the properties of rosolic acid. This acid was discovered by Runge, and is a product of the oxidation of phenol or carbolic acid in the presence of alkalis. It is a dark-coloured amorphous solid substance having a greenish lustre, yielding a red, or, in a very minutely divided state, orange-red powder; it cakes together at 60° Fahr., and melts at 212° to an almost black fluid, is not volatile, does not easily ignite on being heated, but when once so far heated, burning violently with a reddish, sooty flame; it is soluble in alcohol, in methyl-alcohol, soluble in ether (but not so freely as in alcohol), in carbolic acid, and in wood-cresote (Reichenbach's cresote), equally so in strong acetic, hydrochloric, and sulphuric acids; insoluble, however, in chloroform, benzol, sulphide of carbon, essential, and fixed oils. Rosolic acid is not decolourised by sulphurous acid; it is a very weak acid, weaker even than carbonic acid, unites with ammonia, fixed alkalis, alkaline earths, forming dark red compounds soluble in water and alcohol, and easily decomposed by air and light. Soluble rosolates do not form precipitates with salts of heavy metals. The percentage composition of rosolic acid is represented by: C 75.92, H 5.83, O 17.68.

In how far the so-called aurine cake applied by me for experiments is different from the chemically pure rosolic acid, I have had no opportunity to test; in its chief properties I have found the material I experimented with to correspond with the description of the properties of rosolic acid just alluded to.

Desirous to try whether I could not make the solution of aurine to unite intimately, or, rather, mix mechanically with a preparation of lead, I first dissolved some aurine in methylated spirit, next added to this solution an aqueous solution of acetate of lead, and afterwards just sufficient liquid ammonia to produce a precipitate of a highly basic acetate of lead, carrying along with it

the aurine so intimately mixed therewith as to form a beautifully crimson-coloured precipitate; this I collected on a filter, and washed it with distilled water, but soon discovered that all the colour would be washed out if this process were to be continued; in fact, I was well aware that I had only to do with a very intimate mechanical mixture, and not, as is the case, for instance, with carmine lake obtained from cochineal by treating an aqueous solution of that colouring matter, first with a solution of alum, and next with carbonate of soda; I therefore stopped the washing, and dried the magma on a water-bath, afterwards reducing it to a very minutely-divided powder, by grinding it in an agate mortar. I next tried alum; i.e., I dissolved some alum, free from iron, in water, and added to its solution a solution of aurine in carbonate of potassa; as I had foreseen, I did not obtain a real chemical compound, but again a very minutely-divided aurine dispersed through alumina. After a short washing of this, especially in a moist state, most magnificently scarlet-coloured substance, I again dried at 212°, and ground to impalpable powder as just mentioned; in a dry state, this powder exhibits a brilliant dark-orange hue of great brilliancy. I next became desirous to ascertain whether aurine possessed any affinity for recently-prepared phosphate of lime; I therefore dissolved some bone ash of good quality in hydrochloric acid, separated the sand and further insoluble in that acid by filtration, next precipitated by ammonia, collected and washed this precipitate well, and next dissolved the yet moist precipitate in dilute acetic acid; to this solution I added a solution of aurine in ammonia. I so obtained a very bright scarlet-coloured precipitate; but after having collected it on a filter, and commenced washing it, I soon found out that the aurine has not, unlike madder and other dry stuffs, affinity for phosphate of lime. I dried the precipitate obtained again at 212°, and reduced it to a minutely-divided powder afterwards; in a dry state it is still a beautiful pigment, and of an entirely different hue from the preceding. I next tried a solution of aurine in carbonate of ammonia, and precipitated it with chloride of barium; after repeating the process already described again, I obtained in this way a very brilliant flesh-coloured pigment. I mixed, in an earthenware glazed mortar, some aurine cake and strong baryta water, filtered this mixture, and added to the filtrate very weak sulphuric acid, just enough to neutralise the baryta; in this way I obtained a pigment which, after drying (of course some washing, but not to excess), can vie, in beauty and tone of colour, with genuine carmine. I next proceeded to precipitate an aqueous solution of sulphate of zinc with a very slight excess of a solution of aurine in dilute caustic potassa, washing again, slightly, the precipitate, and drying it at 212°; the pigment so obtained has a fine rose colour. On trying sulphate of zinc again, but with a solution of aurine in dilute carbonate of potassa, after drying, a very peculiar and somewhat dull pinkish coloured pigment is obtained. A most magnificently bright scarlet of deep hue is obtained by first triturating together some previously separately-powdered aurine with lime-water (not milk of lime), filtering the turbid liquid, and next passing gently through it a current of carbonic acid gas. A precipitate ensues exhibiting the colour already referred to; on drying it, after having carefully collected it on a filter and slightly washed it, I find that even below 212° its colour is very much altered and impaired. I find, however, on instituting experiments on purpose, that if the pigments referred

to are dried over sulphuric acid at the ordinary temperature, their primitive beauty, as seen on precipitation, and while yet moist, is to a very great extent preserved. As already stated, none of the pigments described are fit for oil colours—I have tried them, but none will do at all; but, undoubtedly, mixed with strong solutions of gum, free from acidity, or good size, or better yet, gelatine and albumen, these pigments might be of use in colouring paper hangings, toys, and other ornaments. As regards the solutions of aurine in weak fixed alkalies and their carbonates, from experiments I instituted, I think I may recommend aurine cake as an article for the manufacture of a red writing fluid—red ink—of great beauty. Of the solutions I tried for this purpose, I find that the solution in carbonate of soda answers best; this red ink can—firstly, be used with steel pens, not only not corroding them, but actually on account of the alkali protecting the steel from rust and corrosion; and, secondly, this ink would not affect blue-laid paper coloured with ultramarine, which latter pigment is decomposed by acids; and, since ordinary red ink is usually very acid, both the pens and paper suffer, if ultramarine blue-laid paper is used for writing. Another advantage of the use of the solution alluded to, instead of red ink, is that it may be safely used by mechanical draughtsmen with their steel drawing instruments, which will not suffer from its use. Tampering with what is written with the alkaline aurine solution, with acids for instance, will at once become evident by the writing becoming yellow, while the primitive colour cannot be restored.

I find that aurine cake is to some extent soluble in an aqueous solution of bicarbonate of soda, yielding a solution of a brilliant scarlet-red hue; on writing with the said solution I found that, after drying, a very pale rose, or, when a more concentrated solution is used, an orange-coloured writing ensues. I prepared all these solutions at the ordinary temperature, by first pulverising the aurine cake in a stoneware or glass mortar, and next adding the aqueous alkaline solution, and rubbing it and mixing together for a length of time, and next filtering through good ordinary white filtering paper. Notwithstanding it is asserted that the colour from rosolic acid is very fugitive, I find that things written now, five, and even eight weeks ago, exhibit no signs of change or fading. Aurine in alkaline solution, far surpasses best red ink in brilliancy; if its asserted instability should, on a more severe and lengthy trial, prove incorrect, alkaline aurine solutions may be of use, also, instead of water colours for drawings, designs, and for mechanical and other draughtsmen, since the colour is extremely brilliant, and the raw material not expensive, considering its immense tinctorial power even in small quantity.

ON CONVENIENT FORMS OF EXPERIMENT WITH FLUID JETS.*

BY PROF. FRANCIS H. SMITH.

THE following descriptions of some serviceable forms of experiment with fluid jets may be of interest to a few of your readers:—

To obtain the water-jet presently referred to, a small

glass funnel was cemented to an opening in the bottom of a bucket. A valve was constructed by wrapping a 3 oz. leaden bullet with buckskin, and suspending it over the funnel from one end of a lever mounted upon the edge of the bucket. Placing the latter upon a tall tripod, and filling it with water, the operator has control of a satisfactory jet which he can start and stop at pleasure. This rude apparatus leaves, perhaps, nothing further to be desired in the way of vertically falling jets.

Exp. 1. Resolution of the jet—A large cylindrical beam of sunlight was introduced horizontally into the darkened chamber. The beam was condensed to a focus, with a double-convex lens. Between this focus and a screen, the jet of water was made to fall; a well defined shadow of the jet was thus thrown upon the screen, and it was easy to see a marked difference in the intensity of the shadow of the tranquil and troubled sections. Just at the focus referred to, was placed a circular disc of cardboard, rotated by clock-work, and perforated all round near its margin, with a number of equidistant holes. When this was properly adjusted and set into rotation, the jet and screen were illuminated by a rapid succession of flashes of light.* Instantly the troubled section of the jet and its shadow was seen to be resolved into vibrating drops. When the flashes followed each other as fast as the drops, the shadows of the latter were stationary on the screen. If the velocity of the disc were now slightly reduced, the shadows slowly descended, and were seen to palpitate from prolateness to oblateness in a surprisingly distinct manner. If the disc be urged to greater speed, the shadows of the drops appear to ascend, according to a well known optical relation. It may be added, that by changing the relative distances of the jet and screen from the illuminating focus, we may make the shadows of the drops so large as to be seen without difficulty from the remotest parts of the largest lecture-room. I need not say that the electric lamp would furnish, in respect of steadiness, a better means of illumination than the sun.

This experiment was first tried by me in October, 1867, with a jet of quicksilver, strongly illuminated. The image of the jet was formed on the screen, and suitably interrupted at short intervals of time. The result was satisfactory, but was liable to the objections that the image was inverted.

Exp. 2.—The jet was chastened into greater regularity of structure by the sound of a monochord, tuned to tension, with it, or more simply by receiving its troubled section upon a resonant surface, so placed that its tremors were transmitted to the reservoir through the legs of the tripod. The phenomena before described were now more marked, the intermittent light enabling us to trace in detail the influence of the sound, in abridging the tranquil section of the jet, and causing incipient swellings and strictures high up upon

* When the disc is spinning very rapidly, the illumination of the screen seems to be continuous, but a white wand or string, or a fiddle-bow, shaken in the light, will demonstrate to the spectators its interrupted character. When the hand, with its fingers extended, is moved rapidly to and fro in the light, a monstrous appearance is presented, which must be seen to be appreciated. The appearance also of a stretched cord vibrated transversely in the intermittent cone of light, is instructive. Its apparent wavings, the velocity of the perforated disc being kept uniform, change of course with the tension of the cord. When the vibrating cord appears stationary, its time of vibration is a multiple or sub-multiple of the interval of the flashes of light. As it is not difficult to decide this "indetermination" we have here, it appears, a method of determining the number of transverse vibrations per second of a tense cord.

* From a communication to J. D. Dana, dated University of Virginia, Feb. 20, 1868.

the latter. The reflection of sonorous beats also may be more narrowly observed by this form of experiment.

Exp. 3.—The jet was received in its smooth section upon a polished circular metallic plate, considerably wider than the jet, and one of Salvart's liquid sheets, ten inches in diameter, was formed. When the unisonant monochord was sounded, the sheet was at once abolished. It was interesting to watch the resolution of the curved sheet of water, in the interrupted light, both with and without the aid of the neighbouring sound.

Experiments with like results were made with oblique and vortically ascending jets. In all cases the intermittent light invested the results with new interest and instruction. If I am not mistaken, the method here described is far preferable in simplicity, certainty, and ease of control, to that of electric flashes from the Leyden jar, whether used for research, or mere lecture-room illustration.

In reference to gaseous jets, allusion will at present be made only to sonorous flames in tubes.—*Am. Jour. of Sci., May, 1868.*

ON THE MEASUREMENT OF THE LUMINOUS INTENSITY OF LIGHT.

BY WILLIAM CROOKES, F.R.S., ETC.

THE measurement of the intensity of a ray of light is a problem the solution of which has been repeatedly attempted, but with less satisfactory results than the endeavours to measure the other radiant forces. The problem is susceptible of two divisions—the absolute and the relative measurement of light.

I. Given a luminous beam, we may require to express its intensity by some absolute term having reference to a standard obtained at some previous time, and capable of being reproduced with accuracy at any time in any part of the globe. Possibly two such standards would be necessary, differing greatly in value, so that the space between them might be subdivided into a definite number of equal parts; or the same result might perhaps be obtained by the well-known device of varying the apparent intensity of the standard light by increasing and diminishing its distance from the instrument.

II. The standard of comparison, instead of being obtained once for all, like the zero- and boiling-points of a thermometer, may be compared separately at each observation; and the problem then becomes somewhat simplified into the determination of the relative intensities of two sources of light.

The absolute method is of course the most desirable; but as the preliminary researches and discoveries are yet to be made, before a photometer, analogous to a thermometer in fixity of standard and facility of observation, could be devised, the realisation of an absolute light-measuring method appears somewhat distant. The path to be pursued towards the attainment of this desirable object appears to be indicated in the observations which from time to time have been made by Becquerel, Herschel, Hunt, and others, on the chemical action of the solar rays, and the production thereby of a galvanic current, capable of measurement on a delicate galvanometer, by appropriate arrangements of

metallic plates and chemical baths connected with the ends of the galvanometer wires.

Many so-called photometers have been devised, by which the chemical action of the rays at the most refrangible end of the spectrum have been measured, and the chemical intensity of light tabulated by appropriate methods; and within the last few years Professors Bunsen and Roscoe have contrived a perfect chemical photometer, based upon the action of the chemical rays of light on a gaseous mixture of chlorine and hydrogen, causing them to combine with formation of hydrochloric acid.

But the measurement of the chemical action of a beam of light is as distinct from photometry proper, as is the thermometric registration of the heat rays constituting the other end of the spectrum. What we want is a method of measuring the intensity of those rays which are situated at the intermediate parts of the spectrum, and produce in the eye the sensation of light and colour; and, as previously suggested, there is a reasonable presumption that further researches may place us in possession of a photometric method based upon the chemical action of the luminous rays of light.

The rays which effect an ordinary photographic sensitive surface, are so constantly spoken of and thought about as the ultra-violet invisible rays, that it is apt to be forgotten that some of the highly luminous rays of light are capable of exerting chemical action. Fifteen years ago* the writer was engaged in some investigations on the chemical action of light, and he succeeded in producing all the ordinary phenomena of photography, even to the production of good photographs in the camera, by purely luminous rays of light, free from any admixture with the violet and invisible rays. When the solar spectrum, of sufficient purity to show the principal fixed lines, is projected for a few seconds on to a sensitive film of iodide of silver, and the latent image then developed, the action is seen to extend from about the fixed line G to a considerable distance into the ultra-violet invisible rays. When the same experiment was repeated with a sensitive surface of bromide of silver instead of iodide of silver, the result of the development of the latent image showed that in this case the action commenced at about the fixed line *b*, and extended, as in the case of the iodide of silver, far beyond the violet. A transparent cell, with parallel glass sides one inch across, was filled with a solution of twenty-five parts of sulphate of quinine to one hundred parts of dilute sulphuric acid; this was placed across the path of the rays of light, and photographs of the spectrum were again taken on iodide of silver and on bromide of silver, the arrangements in all cases being identical with those in the first cited experiments, with the exception of the interposition of the quinine screen. The action of the sulphate of quinine upon a ray of light is peculiar; to the eye it scarcely appears to have any action at all, but it is absolutely opaque to the ultra-violet, so-called chemical rays, and thus limits the photographic action on the bromide and iodide of silver to the purely luminous rays. On developing the latent images, it was now found that the action on iodide of silver was confined to a very narrow line of rays, close to the fixed line G, and in the case of bromide of silver to the space between *b* and G. Designating the spaces of action by colours instead of fixed lines, it was thus proved that, behind a screen of sulphate of quinine, iodide of silver was affected only by the luminous rays

* The Journal of the Photographic Society, vol. 1.

about the centre of the indigo portion of the spectrum, whilst bromide of silver was affected by the green, blue, and some of the indigo rays.

It is very likely that a continuance of these experiments would lead to the construction of a photometer capable of measuring the luminous rays; for although bromide of silver behind quinine is not affected by the red or yellow rays, still it is by the green and blue; and as the proportion of red, yellow, green, and blue rays is always invariable in white light (or the light would not be white but coloured), a method of measuring the intensity of one set of the components of white light would give all the information we want; just as, in an analysis of a definite chemical compound, the chemist is satisfied with an estimation of one or two constituents only, and calculates the others.

Method based upon the foregoing considerations would supply us with what may be termed an *absolute* photometer, the indication of which would be always the same for the same amount of illumination, requiring no standard light for comparison; and pending the development of experiments which the writer is prosecuting in this direction, he has been led to devise a new and, as he believes, a valuable form of *relative* photometer.

A relative photometer is one in which the observer has only to determine the relative illuminating powers of two sources of light, one of which is kept as uniform as possible, the other being the light whose intensity is to be determined. It is therefore evident that the great thing to be aimed at is an absolutely uniform source of light. In the ordinary process of photometry the standard used is a candle, defined by Act of Parliament as a "sperm candle of six to the pound, burning at the rate of 120 grains per hour." This is the standard from which estimates of the value of illuminating gas are deduced, hence the terms "12-candle gas," "14-candle gas," &c. In his work on *Gas Manipulation*, Mr. Sugg gives a very good account of the difficulties which stand in the way of obtaining uniform results with the Act of Parliament candle. A true sperm-candle is made from a mixture of refined sperm with a small proportion of wax, to give it a certain toughness, the pure sperm itself being extremely brittle. The wick is of the best cotton, made up into three cords and plaited. The number of strands in each of the three cords composing the wick of a six-to-the-pound candle is seventeen, although Mr. Sugg says there does not appear to be any fixed rule, some candles having more and others less, according to the quality of the sperm. Sperm-candles are made to burn at the rate of one inch per hour, and the cup should be clean, smooth, and dry. The wick should be curved slightly at the top, the red tip just showing through the flame, and consuming away without requiring snuffing. To obtain these results, the tightness of the plaiting and size of the wick require careful attention; and as the quality of the sperm differs in richness or hardness, so must the plaiting and number of strands. A variety of modifying circumstances thus tend to affect the illuminating power of a standard sperm candle. These difficulties, however, are small, compared with those which have resulted from the substitution of paraffin, &c., for part of the sperm; and Mr. Sugg points out that candles can be made with such combinations of stearin, wax, or sperm, and paraffin, as to possess all the characteristics of sperm candles, and yet be superior to them in illuminating power; while, on the other hand, candles made from *the same materials* otherwise combined are inferior.

When, in addition to this, it is found that candles containing paraffin require wicks more tightly plaited and with fewer strands than those suitable for the true sperm candle, our readers will be enabled to judge of the almost unsurmountable difficulties which beset the present system of photometry.

But assuming that the true parliamentary sperm candle is obtained, made from the proper materials and burning at the specified rate, its illuminating power will be found to vary with the temperature of the place where it has been kept, the time which has elapsed since it was made, and the temperature of the room wherein the experiment is tried.

The Rev. W. R. Bowditch, in his work on *The Analysis, Purification, &c., of Coal Gas*, enters at some length into the question of test-candles, and emphatically condemns them as light-measures; one experiment quoted by this author showed that the same gas was reported to be 14.63 or 17.36 candle gas, according to the way the experiment was conducted.

The present writer has taken some pains to devise a source of light which should be at the same time fairly uniform in its results, would not vary by keeping, and would be capable of accurate imitation at any time and in any part of the world by mere description. The absence of these conditions seems to be one of the greatest objections to the sperm candle. It would be impossible for an observer on the continent, ten or twenty years hence, from a written description of the sperm candle now employed, to make a standard which would bring his photometric results into relation with those obtained here. Without presuming to say positively that he has satisfactorily solved all difficulties, the writer believes that he has advanced some distance in the right direction, and pointed out the road for further improvement.

Before deciding upon a standard light, experiments were made to ascertain whether the electric current could be made available. Through a coil of platinum wire, so as to render it brightly incandescent, a powerful galvanic current was passed; and its strength was kept as constant as possible by a thick wire galvanometer and rheostat. To prevent the cooling action of air-currents, the incandescent coil was surrounded with glass; and it was hoped that by employing the same kind of battery and by varying the resistance so as to keep the galvanometer needle at the same deflection, uniform results could be obtained. In practice, however, it was found that many things interfered with the uniformity of the results, and the light being much feebler than it was advisable to work with, this plan was deemed not sufficiently promising, and it was abandoned. The method ultimately decided upon is the following:—Alcohol of sp. gr. 0.805, and pure benzol boiling at 81° C., are mixed together in the proportion of 5 volumes of the former and 1 of the latter. This burning fluid can be accurately imitated from description at any future time and in any country, and if a lamp could be devised equally simple and invariable, the light which it would yield would, it is presumed, be invariable. This difficulty the writer has attempted to overcome in the following manner.

A glass lamp is taken of about 2 ounces capacity, the aperture in the neck being 0.25 inch diameter; another aperture at the side allows the liquid fuel to be introduced, and by a well-known laboratory device, the level of the fluid in the lamp can be kept uniform. The wick-holder consists of a platinum tube 1.81 inches long and 0.125 inch internal diameter. The bottom of

this is closed with a flat plug of platinum, apertures being left in the sides to allow free access of spirit. A small platinum cup $\frac{1}{5}$ inch diameter and $\frac{1}{4}$ inch deep is soldered round the outside of the tube $\frac{1}{5}$ inch from the top, answering the threefold purpose of keeping the wick-holder at a proper height in the lamp, preventing evaporation of the liquid, and keeping out dust. The wick consists of 52 pieces of hard-drawn platinum wire, each $\frac{1}{100}$ inch in diameter and 2 inches long, perfectly straight and tightly pushed down into the platinum holder until only $\frac{1}{10}$ inch projects above the tube. The height of the burning fluid in the lamp must be sufficient to cover the bottom of the wick holder; it answers best to keep it always at the uniform distance of $1\frac{1}{4}$ inches from the top of the platinum wick; a slight variation of level, however, has not been found to influence the light to an extent appreciable by our present means of photometry. The lamp having the reservoir of spirit thus arranged, the platinum wires parallel and their projecting ends level, a light is applied, and the flame instantly appears, forming a perfectly-shaped cone $1\frac{1}{4}$ inches in height, the point of maximum brilliancy being $\frac{1}{56}$ inch from the top of the wick. The extremity of the flame is perfectly sharp, without any tendency to smoke; without flicker or movement of any kind, it burns, when protected from currents of air, at a uniform rate of 136 grains of liquid per hour. The temperature should be about 60° F., although moderate variations on either side exert no perceptible influence. Bearing in mind Dr. Frankland's observations on the direct increase in the light of a candle with the atmospheric pressure, accurate observations ought only to be taken at one height of the barometer. To avoid the inconvenience and delay which this would occasion, a table of corrections should be constructed for each $\frac{1}{10}$ inch variation of barometric pressure.

There is no doubt that this flame is very much more uniform than that of the sperm candle sold for photometric purposes. Tested against a candle, considerable variations in relative illuminating power have been observed; but on placing two of these lamps in opposition, no such variations have been detected. The same candle has been used, and the experiments have been repeated at wide intervals, using all usual precautions to ensure uniformity. The results are thus shown to be due to variations in the candle and not in the lamp.

It is expected that whoever may be inclined to adopt the kind of lamp here suggested will find not only that its uniformity may be relied upon, but that, by following accurately the description and dimensions here laid down, each observer will possess a lamp of equivalent and convertible photometric value, so that results may not only be strictly comparable between themselves, but, within slight limits of accuracy, comparable with those obtained by other experimentalists. The dimensions of wick, &c., here laid down are not intended to fix the standard. Persons engaged in photometry as an important branch of their regular occupation will be better able to fix these data than the writer, by whom photometry is only occasionally pursued as a means of scientific research. Already many improvements suggest themselves, and several causes of variation in the light have been noticed. Future experiments may point out how these sources of error are to be overcome; but at present there is no necessity to refine our source of standard light to a greater degree of accuracy than the photometric instrument admits of.

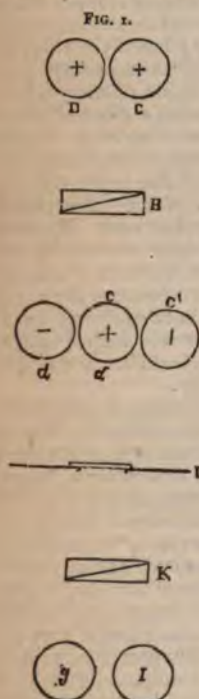
The instrument for measuring the relative intensities of the standard and other lights, next demands attention. The contrivances in ordinary use are well known. Most of them depend on a well-known law in optics, namely, that the amount of light which falls upon a given surface varies inversely as the square of the distance between the source of light and the object illuminated. The simplest observation which can be taken is made by placing two sources of light (say a candle and gas-lamp) opposite a white screen a few feet off, and placing a stick in front of them, so that two shadows of the stick may fall on the screen. The strongest light will cast the strongest shadow; and by moving this light away from the stick, keeping the shadows side by side, a position will at last be found at which the two shadows appear of equal strength. By measuring the distance of each light from the screen, and squaring it, the product will give the relative intensities of the two sources of light.

In practice, this plan is not sufficiently accurate to be used except for the roughest approximations; and from time to time several ingenious contrivances, all founded upon the same law, have been introduced by scientific men, by which a much greater accuracy is obtained: thus in Ritchie's photometer the lights are reflected on to a piece of oiled paper in a box, and their distances are varied until the two halves of the paper are equally illuminated. In Bunsen's photometer, which is the one now generally used, the lights shine on opposite sides of a disc of white paper, part of which has been smeared with melted spermaceti to make it more transparent. When illuminated by a front light the greased portion of the paper will look dark; but if the observer goes to the other side of the paper, the greased part looks the lighter. If, therefore, lights of unequal intensity are placed on opposite sides of a piece of paper so prepared, a difference will be observed; but by moving one backwards or forwards, so as to equalise the intensity, the whole surface of the paper will appear uniformly illuminated on both sides. This photometer has been modified by many observers. By some the disc of paper is moved, the lights remaining stationary; by others the whole is enclosed in a box, and various contrivances are adopted to increase the sensitiveness of the eye and to facilitate calculation: but in all these the sensitiveness is not greatly augmented, as the eye cannot judge of very minute differences of illumination approximating to equality.

In 1833, Arago described a photometer in which the phenomena of polarised light were employed. This instrument is fully described, with drawings, in the tenth volume of the *Œuvres Complètes de François Arago*; but the description, although voluminous, is far from clear. The principle of its construction is founded on "the law of the square of the cosines," according to which polarised rays pass from the ordinary to the extraordinary image. The knowledge of this law, he says, will not only prove theoretically important, but will further lead to the solution of a great number of very important astronomical questions. Suppose, for example, that it is wished to compare the luminous intensity of that portion of the moon directly illuminated by the solar rays with that of the part which receives only light reflected from the earth, called the *partie cendrée*. Were the law in question known, the way to proceed would be as follows:—After having polarised the moon's light, pass it through a doubly refracting crystal, so disposed that the rays, not being able to bifurcate, may entirely undergo ordinary refraction. A lens

placed behind this crystal will therefore show but one image of our satellite; but as the crystal in rotating on its axis passes from its original position, the second image will appear, and its intensity will go on augmenting. The movement of the crystal must be arrested at the moment when, in this growing extraordinary image, the segment corresponding to the part of the moon illuminated by the sun, exhibits the intensity of the ashy part shown by the ordinary image. From these data it is easy to perceive, he says, that the problem is capable of solution.

In another part of the same volume, after speaking of the polariscope which goes by his name, Arago writes:—"I have now arrived at the general principle upon which my photometric method is entirely founded. The quantity (I do not say the proportion)—the quantity of completely polarised light, which forms part of a beam partially polarised by reflection, and the quantity of light polarised rectilinearly which is contained in the beam transmitted under the same angle, are exactly equal to each other. The reflected beam and the beam transmitted under the same angle by a sheet of parallel glass, have in general very dissimilar intensities; if, however, we examine with a doubly refracting crystal, first the reflected and then the transmitted beam, the greatest difference of intensity between the ordinary and the extraordinary images will be the same in the two cases, because this difference is precisely equal to the quantity of polarised light which is mixed with the common light."



desired. The instrument will be better understood if the principles on which it is based are first described.

Fig. 1 shows a plan of the arrangement of parts, not

In Arago's astronomy, the author again describes his photometer in the following words: "I have constructed an apparatus by means of which, upon operating with the polarised image of a star, we can succeed in attenuating its intensity by degrees exactly calculable after a law which I have demonstrated." It is difficult to obtain an exact idea of this instrument from the description given; but from the drawings it would appear to be exceedingly complicated, and to be different in principle and construction from the one now about to be described. The present photometer has this in common with that of Arago, as well as with those described in 1853 by Bernard,* and in 1854 by Babinet,† that the phenomena of polarised light are used for effecting the desired end. But it is believed that the present arrangement is quite new, and it certainly appears to answer the purpose in a way which leaves little to be

drawn to scale, and only to be regarded as an outline sketch to assist in the comprehension of general principles. Let *b* represent a source of light. This may be a white disc of porcelain or paper illuminated by any artificial or natural light. *c* represents a similar white disc likewise illuminated. It is required to compare the photometric intensities of *b* and *c*. (It is necessary that neither *b* nor *c* should contain any polarised light, but that the light coming from them, represented on each disc by the two lines at right angles to each other, forming a cross, should be entirely unpolarised.) Let *n* represent a double refracting achromatic prism of Iceland spar; this will resolve the disc *b* into two discs, *d* and *d'*, polarised in opposite directions; the plane of *d* being, we will assume, vertical, and that of *d'* horizontal. The prism *n* will likewise give two images of the disc *c*; the image *c* being polarised horizontally, and *c'* vertically. The size of the discs *b*, *c*, and the separating power of the prism *n* are to be so arranged that the vertically polarised image *d*, and the horizontally polarised image *c*, exactly overlap each other, forming, as shown in the figure, one compound disc *c d*, built up of half the light from *b* and half that from *c*.

The measure of the amount of free polarisation present in the disc *c d*, will give the relative photometric intensities of *b* and *c*.

The letter *i* represents a diaphragm with a circular hole in the centre, just large enough to allow the compound disc *c d* to be seen, but cutting off from view the side discs *c' d'*. In front of the aperture in *i* is placed a piece of selenite of appropriate thickness for it to give a strongly-contrasting red and green image under the influence of polarised light. *k* is a doubly refracting prism, similar in all respects to *n*, placed at such a distance from the aperture in *i* that the two discs into which *i* appears to be split up are separated from each other, as at *g r*. If the disc *c d* contains no polarised light, the images *g r* will be white, consisting of oppositely polarised rays of white light; but if there is a trace of polarised light in *c d*, the two discs *g r* will be coloured complementarily; the contrast between the green and red being stronger in proportion to the quantity of polarised light in *c d*.

The action of this arrangement will be readily evident. Let it be supposed in the first place that the two sources of light, *b* and *c*, are exactly equal. They will each be divided by *n* into two discs, *d' d* and *c' c*, and the two polarised rays of which *c d* is compounded will also be absolutely equal in intensity, and will neutralise each other and form common light, no trace of free polarisation being present. In this case the two discs of light, *g r*, will be colourless. Let it now be supposed that one source of light (*b* for instance) is stronger than the other (*c*). It follows that the two images *d' d* will be more luminous than the two images *c' c*, and that the vertically polarised ray *d* will be stronger than the horizontally polarised ray *c*. The compound disc *c d* will therefore shine with partially polarised light, the amount of free polarisation being in exact ratio with the photometric intensity of *b* over *c*. In this case the image of the selenite plate in front of the aperture *i* will be divided by *k* into a red and a green disc.

Fig. 2. shows the instrument fitted up. *a* is the eyepiece (shown in enlarged section at Fig. 3). *g n i* is a brass tube, blacked inside, having a piece shown separately at *b c*, slipping into the end *a*. The sloping sides, *b b'*, *c c'*, are covered with a white reflecting surface (white paper or finely-ground porcelain), so that when

* *Comptes Rendus*, April 25, 1853.

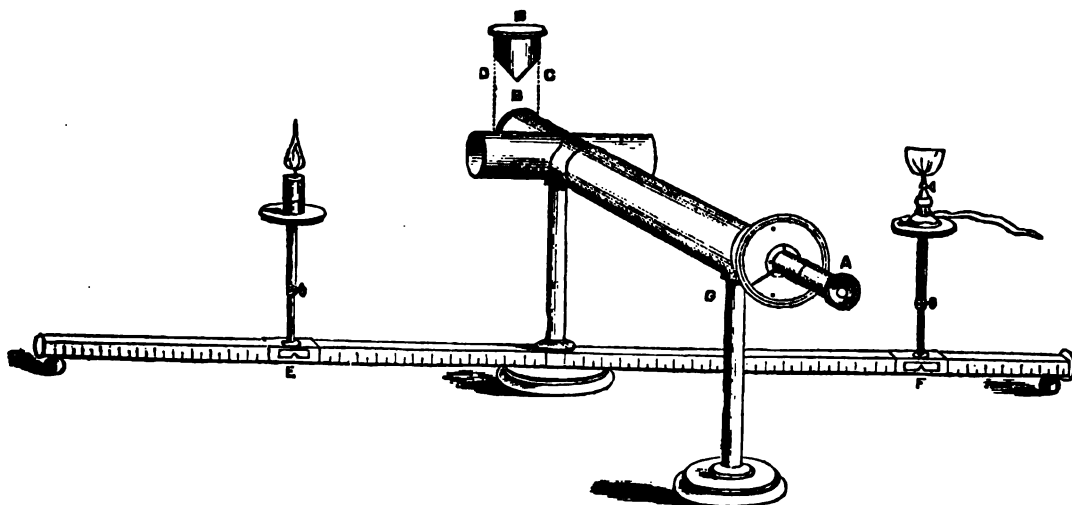
† *Proceedings of the British Association*, Liverpool Meeting, 1854.

bc is pushed into the end b , one white surface, db , may be illuminated (as in Fig. 2) by the candle, and the other surface, bc , by the lamp. If the eye-piece a is removed, the observer, looking down the tube ab , will see at the end a luminous white disc divided vertically into two parts, one half being illuminated by the candle c , and the other half by the lamp f . By moving the candle c , for instance, along the scale, the illumination of

the half db can be varied at will, the illumination of the other half remaining stationary.

The eye-piece a (shown enlarged at Fig. 3) will be understood by reference to Fig. 1, the same letters representing similar parts. At L is a lens to collect the rays from db (Fig. 2), and throw the image into the proper part of the tube. At M is another lens, so adjusted as to give a sharp image of the two discs into

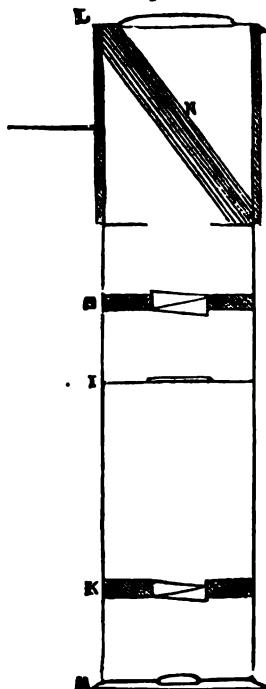
FIG. 2.



which i is divided by the prism x . The part x is an adaptation of Arago's polarimeter; it consists of a series of thin plates of glass capable of moving round the axis of the tube, and furnished with a pointer and graduated arc (shown at A, G , Fig. 2). By means of this pile it is possible to partially polarise the rays coming from the illuminated discs in one or the other direction, and thus bring to the neutral state the partially polarised beam cd (Fig. 1), so as to get the images gr free from colour. It is so adjusted that when at the zero point it produces an equal effect on both discs.

The action of the instrument is as follows. The standard lamp being placed on one of the supporting pillars which slide along the graduated stem (Fig. 2), it is adjusted to the proper height, and moved along the bar to a convenient distance, depending on the intensity of the light to be measured; the whole length being a little over four feet, each light can be placed at a dis-

FIG. 3.



tance of twenty-four inches from the disc. The flame is then sheltered from currents of air by black screens placed round, and the light to be compared is fixed in a similar way on the other side of the instrument. The whole should be placed in a dark room, or surrounded with non-reflecting screens; and the eye must also be protected from direct rays from the two lights. On looking through the eye-piece two bright discs will be seen, probably of different colours. Supposing c represents the standard flame, and f the light to be compared with it, the latter must now be slid along the scale until the two discs of light, seen through the eye-piece, are about equal in tint. Equality of illumination is easily obtained; for, as the eye is observing two adjacent discs of light, which pass rapidly from *red-green* to *green-red*, through a neutral point of no colour, there is no difficulty in hitting this point with great precision. It has been found most convenient not to attempt to get absolute equality in this manner, but to move the flame to the nearest inch on one side or the other of equality. The final adjustment is now effected at the eye-end, by turning the polarimeter one way or the other up to 45° , until the images are seen without any trace of colour. This will be found more accurate than the plan of relying entirely on the alteration of the distance of the flame along the scale; and by a series of experimental adjustments, the value of every angle through which the bundle of plates is rotated can be ascertained once for all, when the future calculations will present no difficulty. Squaring the number of inches between the flames and the centre will give their approximate ratios; and the number of degrees the eye-piece rotates will give the number to be added or subtracted in order to obtain the necessary accuracy.

The delicacy of the instrument is very great. With two lamps, each about twenty-four inches from the

centre, it is easy to distinguish a movement of one of them to the extent of 1-10th of an inch to or fro; and by using the polarimeter, an accuracy considerably exceeding that can be attained.

The employment of a photometer of this kind enables us to compare lights of different colours with one another, and leads to the solution of a problem which, from the nature of their construction, would be beyond the powers of the instruments in general use. So long as the observer, by the eye alone, has to compare the relative intensities of two surfaces respectively illuminated by the lights under trial, it is evident that unless they are of the same tint it is impossible to obtain that absolute equality of illumination in the instrument which is requisite for a comparison. By the unaided eye one cannot tell which is the brighter half of a paper disc illuminated on one side with a reddish, and on the other with a yellowish, light; but by using the above-described photometer, the problem becomes practicable. For instance, on reference to Fig. 1, suppose the disc *b* were illuminated with light of a reddish colour, and the disc *c* with greenish light, the polarised discs *d' d* would be reddish and the discs *c c'* greenish, the central disc *c d* being of the tint formed by the union of the two shades. The analysing prism *k*, and the selenite disc *i* will detect free polarisation in the disc *c d*, if it be coloured, as readily as if it were white; the only difference being that the two discs of light *g r* cannot be brought to a uniform white colour when the lights from *b* and *c* are equal in intensity, but will assume a tint similar to that of *c d*. When the contrasts of colour between *b* and *c* are very strong—when, for instance, one is a bright green and the other scarlet—there is some difficulty in estimating the exact point of neutrality; but this only diminishes the accuracy of the comparison, and does not render it impossible, as it would be according to other systems.

No attempt has been made in these experiments to ascertain the exact value of the standard spirit-flame in terms of the parliamentary sperm candle. Difficulty was experienced in getting two lots of candles yielding light of equal intensities, and when their flames were compared between themselves and with the spirit-flame, variations of as much as 10 per cent. were sometimes observed in the light they gave. Two standard spirit-flames, on the other hand, seldom showed a variation of 1 per cent., and had they been more carefully made they would not have varied 0.1 per cent.

This plan of photometry is capable of far more accuracy than the present instrument will give. It can scarcely be expected that the first instrument of the kind, roughly made by an amateur workman, should possess equal sensitiveness with one in which all the parts have been skilfully made with special adaptation to the end in view.—*Quarterly Journal of Science.*

ON A CONVENIENT FORM OF ASPIRATOR.

BY PROFESSOR ALBERT R. LEEDS,
OF HAYFORD COLLEGE, PA.

A PAIL containing water is placed at the edge of the table, and to the stop-cock which is attached to the side of the pail near the bottom, a tube of two or three feet in length is connected, to carry off the water to a bucket placed on the floor below. When the bucket is filled, the stop-cock is turned off for a moment, and the water poured back into the pail. To the top of the

stop-cock tube, which should be made straight and somewhat longer than usual, and in front of the stop-cock itself, a short vertical tube is attached and connected by means of india-rubber tubing with the wash-bottle, or other vessel through which gas is to be drawn. On partially opening the stop-cock, the deficiency of water is made up by a large quantity of air or gas, which is drawn in through the vertical tube above mentioned.—*Am. Journ. Sci.*, May, 1868.

ANALYSIS OF PYRITES' RESIDUE.

BY DR. T. L. PHIPSON, F.C.S., &C., LONDON.

THE following analysis represents the residue of pyrites obtained in the Drumburgh Chemical Works, Cumberland, where Norwegian pyrites is principally burnt:—

Oxide of zinc.....	5.50
" copper	2.86
" manganese.....	1.60
" nickel and cobalt.....	0.12
" cadmium	0.01
" lead.....	1.67
" antimony.....	0.04
Protoxide of iron.....	1.17
Alumina	3.25
Arsenic.....	none
Sulphur	2.60
Thallium and indium.....	trace
Rock	15.00
Peroxide of iron (by difference).....	65.99
direct 67.00	
Lime	0.11
Magnesia.....	0.08
	100.00

The figures representing zinc, copper, and sulphur are the mean results of several analyses; the other substances were only once determined. The rock, or gangue, consists in this case entirely of quartz and mica schist; it is, therefore, principally silica. The sulphur is mostly free, and often visible. In the deposit formed in the tunnel itself only a trace of arsenic was found. The red flue dust differs considerably from this residue in its composition; and this again differs from the deposits in the tunnel—especially when the latter gets too hot—and from that in No. 1 chamber adjoining.

ON SOME OF

THE CONSTITUENTS OF COAL GAS.*

A LECTURE BY DR. ODLING, F.R.S., F.C.S.,
BEFORE THE BRITISH ASSOCIATION OF GAS MANAGERS.

EVER since the French Exhibition of last year there has been much public talk and discussion about the decline of English scientific manufactures, especially in relation to those of the Continent. It has been asserted very boldly that we in this country—where gas lighting took its origin, where the first locomotive ran, and where some of the earliest and greatest successes of the electric telegraph have been achieved—are not making such a degree of progress in scientific manufactures as continental nations are. Now, whether this be the fact or not—and for my own part I am by no means disposed to admit it as a fact—the circumstance of such an allegation being made is, I conceive, a warning to us that we must for the future devote our

* Reprinted, by permission, from the *Journal of Gas Lighting*.

best energies and wisest consideration to the development of our different scientific industries. Now & days the universal panacea for every shortcoming appears to consist in the establishment of what are called technical schools. It is difficult for outsiders to form an exact notion of what is to be the character and purpose of these technical schools, but the prevalent opinion, as I understand it, is something of this kind. Hitherto our mode of teaching young men the business of their future lives has been altogether wrong, and we must at once resort to an entirely different system. Instead of letting them learn their business at factories where work is done for a profit—where it is done in the only way in which it can be done on a large scale, and for useful purposes—they are to learn their business at special schools, where all work is to be done solely or primarily with a view to education. Henceforward, instead of gas managers learning the business of gas manufacture at actual gas-works, they are to study at model gas-works; metallurgists at model smelting-works; and machinists at model foundries and workshops. Now, in common with many of my scientific friends, and more especially Dr. Williamson, who has devoted much valuable thought to the subject, I venture to dissent very strongly from these views. I hold, and I think you will agree with me, that the only place in the world where you can learn to make gas properly is in an actual gas factory, and the only place where you can learn to make and work iron properly is at some actual iron works. But with regard to science the case is very different; and instead of founding technical schools to teach manufacturing art, I believe it would be of much greater advantage to make the principles of science a far more prominent subject of study at our ordinary schools, so that when young men enter upon their work as manufacturers, they may be able to apply to their respective businesses the exact scientific principles which they will have acquired by the study of abstract science elsewhere. Let science, then, be taught in schools, and the application of science in works conducted on ordinary commercial principles.

These remarks are preliminary to what I have to say to you this evening. I do not come here pretending to teach you how to make or purify gas, for you know that much better than I do; but, inasmuch as gas-making is your business, and chemistry is mine, I want to tell you a little about the mere chemistry of your manufacture, and possibly throw out a hint or two that you may be able practically to apply. I wish to point out to you the purely chemical qualities of some of the bodies with which you are dealing, leaving you to make the application of the knowledge, as you are so well able to do. And, even in this limited matter, I am placed in considerable difficulty, for I find that my friend, Dr. Letheby, has gone pretty nearly over the whole of the ground in his previous lectures to you. I have read four of those lectures, and certainly with a great deal of profit, but I cannot say altogether with pleasure, for it is not a pleasant thing to find that, if not all, at least the finest plums have been already plucked from the tree. I can only attempt, therefore, to go a little more into chemical detail than Dr. Letheby has done with regard to some of the principal constituents of coal gas, and I purpose confining my attention almost exclusively to those constituents which do not contribute very largely to its illuminating power.

The first of these to which I will direct your attention is hydrogen. Hydrogen is an important consti-

tuent of ordinary coal gas, and its proportion varies very considerably in gases of different manufacture. It ranges from 12 to 50 per cent, and more frequently approximates to the higher than to the lower quantity. In ordinary London gas the proportion is usually about 40 per cent. Hydrogen gas is characterised by its burning with an almost invisible flame. I have here a jet of the burning gas, but, unless I introduce into the flame a piece of platinum wire, I doubt very much whether those gentlemen who are sitting at a distance can distinguish it; and, even with the piece of platinum inserted, the flame is scarcely visible.

In addition to the non-luminosity of its flame, hydrogen is very interesting, for this reason, that it is the only constituent of coal gas which, whether burned at a high or a low temperature, with excess or deficit of air, yields the same product of combustion. I want to give you an illustration of the mode of burning hydrogen at a low temperature, and that I can readily do by bringing into contact with the pure gas as it issues from the jet a piece of platinum sponge mixed with a considerable proportion of clay. On bringing this into contact with the hydrogen, you see that the ball of platinum clay soon becomes feebly red hot. Under these circumstances a small portion only of the issuing hydrogen is being burned, but that small portion so burned is being as completely converted into water as it would be in the oxyhydrogen blowpipe. At present the platinum ball, though very hot—just below a dull red heat—is not sufficiently hot to inflame the hydrogen. In order to effect the inflammation we must bring the light of a flame into contact with the gas, when it at once takes fire, as you perceive. This is the only point upon which I have to offer any remark on the subject of hydrogen—viz., that it may be burned at a high or low temperature, with flame or without, but the product of combustion is always the same,—viz., water.

The next constituent of coal gas to which I shall refer is marsh gas, the most abundant, indeed, of all the constituents. It forms generally from 30 to 60 per cent by volume, and burns with a pale luminous flame. We have here some marsh gas, though not quite pure, and you observe that it burns with a yellowish flame, having but a slight luminosity. I now want to give you an illustration of the mode of burning this gas at a low temperature. In this case, instead of employing platinum sponge, I shall employ a piece of platinum foil. There is, you perceive, a very considerable degree of heat produced during the operation, but not sufficient to inflame the marsh gas, although the platinum foil becomes distinctly red hot. Now, when marsh gas is burned thoroughly, it yields products which consist almost entirely of carbonic acid and water; but when it burns in this way it gives rise to ill-defined products, which have an acid reaction, a disagreeable smell, and a power of reducing certain metallic salts. It is of very great importance in burning coal gas that you should get as thorough a combustion as possible, because all these half-burned products have an offensive smell, and it is to their presence that the smell of artificially-illuminated rooms is due.

I will now repeat this experiment with the platinum foil, but instead of taking marsh gas I will employ hydrogen, and you will see that directly I bring the foil into contact with it the gas inflames, the hydrogen being much more easily set fire to than the marsh gas. It is a striking property of hydrogen, as compared

with marsh gas, that the degree of temperature which is not sufficient to inflame the latter inflames the former very readily; but though this is true of hydrogen in a pure state, it is not true of it when mixed with the other constituents of coal gas. It is sometimes suggested that because hydrogen gas is capable of being inflamed at an exceedingly low temperature, therefore its presence renders coal gas very inflammable; but such is not the case, for though the coal gas we have here contains 40 per cent of hydrogen, we may make this piece of platinum foil suspended over it exceedingly hot, and yet it will not set fire to the gas; whereas when we were employing pure hydrogen, even though the platinum became but just visibly red, it was sufficient to inflame the gas, but diluted as the hydrogen now is to a large extent with marsh gas, the far more strongly heated platinum fails to inflame it.

And this leads me to make an observation or two upon the general nature of flame. I, who stand a little above the imperfectly burning coal gas, have the disadvantage of the smell which arises during the imperfect combustion. Some of you will remember that a little time ago, when large massive iron burners were employed for heating purposes, they also gave rise to a very offensive smell. Now, there is an impression abroad that although when gas is burned with an insufficient supply of air you do not burn it thoroughly, yet that if you burn it with an excess of air you cannot fail to effect its thorough combustion. But with all those iron burners the gas was burned with an excess of air, and the proof was that you only got a blue non-luminous flame; nevertheless you did not produce anything like a complete combustion of the gas into carbonic acid and water, as evidenced by the offensive smell of the products actually formed. The same thing frequently happens with the Leslie burner when used improperly. When a rich gas is employed, and the chimney is properly adapted, the combustion of the gas is as perfect as possible; but this is not the case in burning from a foot to a foot and a half per hour, when you only get a blue flame just tipped with yellow. Although the gas is then being burned with a large excess of air, you are, nevertheless, not so thoroughly burning the gas as when there is a less proportion of air. We shall readily see how this must be so. In every flame, you may take it, there is an interior portion or core, which is the gas itself; surrounding that is a mixture of air and gas in about the right proportion to give a luminous flame, and around that there is an external film of gas with air in excess. In the intermediate portion of the flame the combustion is most perfect, though far from complete, and the temperature highest. The core of coal gas surrounded by this intermediate extremely hot layer is decomposed by the heat to which it is exposed just as it would be decomposed in a white hot retort. The decomposed gas is then burned to a more or less complete extent in the intermediate luminous cone—never to a complete extent, since it is always burned with a deficient supply of air, being separated from the surrounding air by the external non-luminous film in which the air is in excess. But even in this external film the perfect combustion of the residual gas is never absolutely achieved, and for several reasons—first of all, because the residual gas is mixed up with so large a quantity of air which requires to be heated to a much higher temperature than the amount of heat in the flame is capable of imparting to it; and, secondly, because the residual gas and air are also necessarily mixed up with the

incombustible products of the gas that is already burnt in the luminous cone. Accordingly, in the exterior film, notwithstanding the large excess of air, the combustion is not complete, because of the cooling effected by the large excess of air, and because of the diluting effect of the products of combustion.

Now, it will be found that the complaints which arise about the closeness of rooms heated by gas arise partly from the amount of steam produced, which makes the atmosphere damp, and interferes with free perspiration, and partly from the formation of imperfectly burned products, since in all lamps and candles the combustion is never perfected. There are always some half-burned products thrown off which give rise to the sense of closeness which is not peculiar to gas, but is noticed chiefly in the case of gas, because gas being the cheapest of all illuminating agents, we are apt to burn it most extravagantly.

Now, I want to give you some experimental illustrations of the nature of flame. Here I have a flask, which is supplied with coal gas from an opening blown in its side. At the bottom of the flask is an open tube communicating with the atmosphere, and you will find in this case that we can burn atmospheric air just as well in coal gas as we can burn coal gas in atmospheric air. You see, in fact, that the combustion takes place wherever the two layers come in contact with each other. Here we are burning the gas in air; in the other case we are burning the air in gas. In each case we have in reality a shell of flame, the difference being that in the one case the air is on the outside, in the other it is on the inside. By blowing gently into the air-tube you observe that I am actually able to burn my own breath in an atmosphere of coal gas, just as I might burn a small jet of coal-gas in the atmosphere of my mouth. Now, let me give you another illustration of the nature of the combustion of coal gas. We have here a cylinder of coal gas, and in it I may burn any highly-oxidised salt. I may burn, for instance, nitre. Nitre will take fire and burn in coal gas, just as a sulphur match will burn in air. In this case I am not going to burn nitre, but chlorate of potassium, which is a more convenient salt. I make the chlorate just red hot. You observe it does not burn at all in the air, but directly I introduce it into the coal gas it bursts into flame. Here, again, it is simply a question of where the two reacting bodies come in contact with each other. In ordinary circumstances we have the combustible match surrounded by oxygenous air; here we have the oxygenated salt surrounded by combustible gas.

In the Bunsen burner air and coal gas are mixed together before their combustion, whereby we get an almost solid flame; but even in this burner the problem of perfect combustion is not absolutely achieved, nor is it in the best contrivances with which I am acquainted. I believe the most perfect combustion practically attainable takes place in those luminous flames where you do not, indeed, get the maximum yield of light, but where the gas is a little over-burnt with production of a very white flame, as in some of the different forms of button-burner, in Leslie's burner, &c.

The next constituent of coal gas to which I wish to call your attention is ammonia. The proportion of ammonia in London gas is very small. We find that 1 grain of ammonia in 100 cubic feet of gas is sufficient to affect turmeric paper; upon which ordinary London gas is usually without or almost without action. Ammonia is a very interesting substance to gas manufac-

turers. Of all the common gases—i. e., of all gases which are not chemical curiosities—it is the one most soluble in water. At mean temperature, 1 cubic inch of water will dissolve 783 cubic inches of ammonia. The dissolution of ammonia in water takes place with very great rapidity. I have here a sealed glass tube, filled with ammonia gas. On breaking the end of the tube under water coloured with red litmus, you perceive that the contained ammonia is absorbed in an instant, and the tube immediately and completely filled with the water, now turned of a blue colour by the action of the ammonia. This is a very striking experiment. It would seem at first sight to warrant the notion that, since 1 cubic inch of water will dissolve 783 cubic inches of ammonia, and dissolve it at this extremely rapid rate, the removal of ammonia from coal gas must be a very easy problem. But such is far from being the fact. The tube with which I have been experimenting was completely full of ammonia, unmixed with any other gas; but the tube I now hold in my hand contains but 75 per cent of ammonia gas mixed with 25 per cent of air. And you will observe how very much more slowly the liquid will rise up in this case. It makes a very great difference in the dissolution of a gas whether we are dealing with the gas itself pure and simple, or whether we have it diluted to a certain extent with air. I now break the point of the tube under water, and you see at what a slow, scarcely noticeable, rate the gas gradually dissolves, and the water consequently rises in the tube; so much so, that the complete solution of the gas will scarcely be effected by the conclusion of my lecture. Here you see how great a difference it makes whether you are dealing with ammonia by itself, or whether you are dealing with what is substantially ammonia, but which contains in admixture some 25 per cent of air or coal gas. But, after all, in reference to the dissolution of ammonia in water, the difference in the rate of solution between a gas consisting entirely of ammonia and one consisting of ammonia to the extent of 75 per cent is as nothing compared with the difference between this latter and a gas of which the ammonia amounts to a few per cents only, such as that with which you have to deal.

I want to illustrate to you in another way the fact that the solubility in water of a gas by itself, and of the same gas when mixed with other gases, is a very different thing. In illustration of this, I would call your attention to the difficulty there is in dissolving up from the air substances which by themselves are exceedingly soluble. This is an empty 4 lb. bottle, and into it I am going to put a few drops of strong ammonia. Having done this I now introduce a glass rod moistened with a little muriatic acid, and by this means I shall produce an abundance of white fumes of sal ammoniac inside the bottle. The bottle soon gets full of them. Now, sal ammoniac is a very soluble substance indeed; but you will observe the difficulty which I have in dissolving up these fumes of sal ammoniac from the air in the bottle. I half fill the bottle with water, whereby, as you see, a good deal of the fume is blown out; nevertheless, though I shake the bottle about, the remainder does not disappear. You see what a difficulty there is in dissolving, not sal ammoniac itself, but sal ammoniac when forming say 1 per cent or a half per cent of air. Indeed, I have to shake up the bottle very violently and for some time with this large excess of water, in order to get rid of the fume altogether. This shows that the mere passage of any gas over a considerable extent of watery surface will not be sufficient to cause

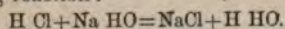
its soluble impurities to be taken up, but that long contact or considerable agitation with the water is required.

I will now give you another illustration of the same difficulty. I have here a bottle containing strong ammonia, and here another containing sulphuric acid. The sulphuric acid is very much stronger than that with which gas managers are in the habit of washing their gas. It is of about the strength of ordinary brown acid; nevertheless you will see that on blowing through the first bottle I shall get a current of air charged with ammoniacal vapour, and that, on its passage through this comparatively strong sulphuric acid, the whole of the ammonia will not be removed. You perceive that the gas which has bubbled up through the sulphuric acid has, notwithstanding, the property of browning turmeric paper; and on passing it for a few minutes through red infusion of cabbage, the red colour of the liquid is turned successively purple, blue, and finally green. The strong acid, employed in this way, is quite powerless to remove from the air the ammonia which it has taken up by its passage through the solution of ammonia. This shows how very difficult it is sometimes to remove small proportions of ammonia, not only by a substance like water, in which it simply dissolves, but even by sulphuric acid, with which it enters in a chemical combination. And this is true, not only of ammonia, but of all other impurities of coal gas; when they are reduced to small quantities it is most difficult to get rid of them entirely. The nearly pure gas requires to come into most intimate contact with the several absorbent substances employed for a considerable length of time in order to become entirely freed from impurity.

With regard to ammonia, I will show you one other experiment. Though, as I have said, this gas is so soluble that one volume of water will dissolve 783 volumes of ammonia, nevertheless it is very readily removable from water by the agency of air, or coal gas, or, indeed, any gaseous substance whatever. Accordingly you will find that even the weakest solution of ammonia will give off some of its ammonia upon agitation with a considerable volume of air. I will take two 4 lb. bottles, and half fill each of them with water. Into each of these bottles I will now suspend a piece of ordinary red litmus paper, just damped slightly. The one bottle contains pure water, and I do not expect to find the paper in it affected at all; but to the 2 lbs. of water in the other bottle I will add three drops only of solution of ammonia—i. e., of ammonia gas already dissolved in about two drops of water—and yet this 2 lbs. of water will not be able to retain all the ammonia and prevent its diffusing into the air. Upon shaking up the bottle, the ammonia diffuses itself out of the water into the air above it, and in a few minutes you will see that the litmus paper (which I now suspend in the air of the bottle) has become completely blue, through the minute proportion of ammonia in the water having partially escaped into the air above it.

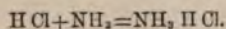
I will now direct your attention to the mode in which ammonia combines with acids to form salts. Of all metallic salts chloride of sodium, or common salt, is the most familiar, and may conveniently be taken as the type. It consists of one proportion of sodium, having the relative weight 23, combined with one proportion of chlorine, having the relative weight 35. Writing each of these proportions by the symbols Na (natrium) and Cl respectively, common salt is expressed by the symbol NaCl. Now, it will be observed that common

salt, or chloride of sodium differs from muriatic acid, or chloride of hydrogen, HCl, in the circumstance of its containing a proportion of sodium having the relative weight 23 instead of a proportion of hydrogen having the relative weight 1; and in a similar manner it will be found that metallic salts in general are formed from acids by the substitution of metal for the hydrogen of the acid. Thus, when muriatic acid is neutralised with caustic soda, NaHO, common salt is produced by the following reaction:—



We begin with chloride of hydrogen, and end with chloride of sodium.

But the formation and constitution of ammonia salts are very different. In order to make sal ammoniac, or chloride of ammonium, I do not replace the hydrogen of the acid by any metallic substance whatever, but I combine the entire acid, hydrogen and all, with ammonia, thus:—



And similarly with regard to the sulphate, nitrate, oxalate, and other salts of ammonia, they are all of them constituted of the original hydrogen acid, or hydrated acid, combined directly with ammonia.

But salts of ammonia present a very remarkable resemblance in many of their properties to ordinary metallic salts, more particularly to salts of potassium, and in a less degree to salts of sodium. Hence, some chemists are disposed to regard ammonia salts as really containing a metal—not a simple metal like sodium, but a compound metal formed by the union of the ammonia with the hydrogen of the acid. Accordingly they represent sal ammoniac not by the formula $\text{NH}_4 \text{ Cl}$, but, instead, by the formula $(\text{NH}_4) \text{ Cl}$; and they call it not muriate or hydrochlorate of ammonia, but, instead, chloride of ammonium. Now, there is one very striking property of ammoniacal salts which, so far as it goes, is strongly in favour of this view—which really seems to show that ammonia can unite with the hydrogen of muriatic acid to form a compound metal.

The evidence is of this kind: Mercury, which is the only metal existing in the liquid state at ordinary temperatures, is capable of uniting with many other metals, but with no other bodies than metals, to form semi-liquid or pasty alloys, which are called amalgams. Gold and silver, indeed, are usually extracted from their respective ores by the process of amalgamation. The precious metals are first dissolved in mercury; the excess of mercury is then strained or squeezed off; and the soft or pasty amalgam submitted to distillation. Now, when chloride of sodium is decomposed by the galvanic battery, chlorine is liberated at one pole and metallic sodium at the other, and if this other pole be formed of a drop of mercury, the sodium, as it is set free, is taken up by the drop of mercury to form sodium amalgam. Similarly, when chloride of ammonium is decomposed by the galvanic battery, chlorine is liberated at the one pole, while there is formed at the other, in presence of a drop of mercury, an abundant amalgam, which consists of nothing but mercury, ammonia, and hydrogen. Now, since amalgams are formed only by the union of mercury with metals, the production of an ammonium amalgam is some evidence that its constituents, ammonia and hydrogen, are contained in the amalgam in the form of a compound metal.

I am able to produce this ammonium amalgam in another form, and to show it to you on a somewhat large scale. I have here some sodium amalgam already

prepared by dissolving metallic sodium in heated mercury, and if I now pour this amalgam into a solution of chloride of ammonium, the chlorine leaves the latter salt to unite with the sodium of the amalgam and form chloride of sodium, while the ammonium takes the place of the sodium and unites with the mercury to form ammonium amalgam. You see directly, I pour in the liquid amalgam of sodium, the bulky pasty amalgam of ammonium is at once formed, which, expanding to some hundred times its original bulk form the evolution of interstitial hydrogen, speedily overflows the vessel. Accordingly, ammonia salts may be regarded either as direct combinations of ammonia (NH_3) with the hydrated acids, such as hydrochloric acid (HCl), sulphuric acid (H_2SO_4), &c.; or as derivatives of the several acids through a replacement of their hydrogen by the compound metal ammonium (NH_4). Which of these views is most correct must be regarded as an open question. Some facts are in favour of the one view, and some the other. Most chemists are now in the habit of employing both modes of representation alternatively in different cases.

Ammonia is a very interesting body in another relation altogether. It is of all unflammable bodies the one which approaches nearest to being inflammable. Here we have, in this flask, some solution of ammonia which, upon being gently heated, furnishes us with an abundant supply of ammonia gas. On applying a light the gas burns, as you see, with a pale green flame, but on taking away the light it ceases to burn. The heat produced by its own combustion is not sufficient to maintain it in combustion, and it only burns in contact with the flame of some other body. But though it will not burn in air it will burn in oxygen gas, and I will now give you an illustration of the combustibility of ammonia in oxygen gas. On surrounding the jet of ammonia by a current of oxygen you observe that it burns I might almost say brilliantly, with its characteristic greenish yellow flame.

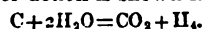
Why does ammonia burn so freely in oxygen gas and so difficultly in air? There are several reasons, the principal one being that when the ammonia burns in air, for every one volume of oxygen which takes part in the action, and which has to be heated up to the temperature of the flame, there are four parts of nitrogen which have also to be heated up to the same temperature, but which contribute nothing to the action or the temperature. Moreover, when burning in oxygen, the jet of ammonia is at any given instant in contact with five times as much oxygen as when burning in air. I can give you another illustration of the combustibility of ammonia gas in a somewhat different form. I take a Florence flask, and into it I pour a little strong solution of ammonia. I now place over the strong ammonia a coil of platinum wire, which is first heated just to redness. You perceive that the platinum wire exposed to the ammonia continues to glow for a considerable time; and if I now pass into the gas a rapid stream of oxygen, ignition of the wire becomes more intense by reason of the chemical combination taking place between the ammonia and oxygen, and in a minute or two it becomes so hot as to inflame and explode the mixture of gases.

The fumes remaining in the flask are an evidence of the oxidation which has taken place, not only of the hydrogen of the ammonia into water, but of its nitrogen into nitrous or nitric acid. This is an important fact with regard to the combustion of ammonia, for we shall find, when speaking of sulphur in gas, that this

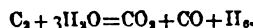
sulphur is oxidised by burning into sulphurous acid only, which, when sufficiently diluted, is a very innocent substance; whereas if considerable portions of ammonia are present in the burning gas, the ammonia in burning yields different oxides of nitrogen, which effect a partial conversion of the sulphurous acid into sulphuric acid. In burning ammonia, then, we find that the hydrogen of the ammonia unites with oxygen to form water, whereas the nitrogen of the ammonia is partially liberated in a free state as nitrogen gas, and partly transformed into nitrous acid. Accordingly, we always get by the combustion of ammonia a certain amount of nitrous acid, which acts as a powerful oxidizing agent. In ordinary purified gas, however, the proportion of ammonia is so exceedingly minute—in most cases insufficient to affect turmeric paper at all—that this point respecting its products of combustion is not of any practical interest. There is one other mode of burning ammonia to which I will direct your attention for an instant, which has a more practical bearing. Although ammonia will not burn in air by itself, it will burn in air if mixed with some other inflammable gas. I am here burning some hydrogen gas, and now, instead of burning it directly, I will first pass it through strong ammonia, when you perceive that the size of the flame is very much increased, and its appearance entirely altered from the considerable combustion of the ammonia which the hydrogen has taken up. You see, therefore, that in removing the ammonia from your gas you do really remove a combustible, and even to some extent a luminiferous constituent of the gas.

Now, a word or two with regard to another constituent of coal gas—viz., carbonic oxide. Carbonic oxide exists in ordinary coal gas to a comparatively small extent, the proportion varying from 5 to about 15 per cent. This gas is characterized by its burning with a feebly luminous but decidedly blue flame. I have here some of it in a holder, and you see the clear blue flame by which its combustion is characterised. We will now substitute for the glass tube an ordinary burner; but though I am using the largest sized bat'wing, I am able to get but a very small flame, carbonic oxide being a gas which is very soon burned out. Now, although carbonic oxide exists to the extent of from 5 to 15 per cent in ordinary coal gas, it exists in a much larger percentage in the gas that is produced by passing steam over ignited coke. You will remember that at one time there was a project for making illuminating gas by means of steam passed over coke. The gas so produced has itself no illuminating power, but we may give it an illuminating power by burning with it some luminiferous hydrocarbon, such as benzol, or by introducing into its flame a coil of platinum wire. Here we have a U-tube containing pumice and benzol, and we will now pass through it some of this carbonic oxide gas. You will see that it is a very excellent purveyor of the hydrocarbon, and that we thus get a very luminous flame, because carbonic oxide is the gas which, for an equal quantity of oxygen, gives out by its combustion the largest proportion of heat—larger even than hydrogen—in the proportion of 68 to 57. The other mode of giving illuminating power to the originally non-luminous flame, and which seems to some extent a considerable success, is by means of a coil of platinum wire. On holding this piece of wire in the flame, it becomes of almost dazzling whiteness, and radiates light abundantly. I remember once seeing a room of the Royal Society illuminated in this manner for a few hours, and I think it is a question whether this steam

gas may not, after all, be made something of. When steam passes over coke, the coke being heated merely to dull redness, there is scarcely any carbonic oxide gas produced—it is nearly all hydrogen and carbonic acid. The kind of action is shown in this equation:—



But when we employ a full red heat the kind of action is different. Under those circumstances we have this reaction:—



So that after the removal of the carbonic acid gas by lime there is left a mixture of three volumes of hydrogen with one of carbonic oxide. There is a great prejudice against the use of carbonic oxide, from its extremely poisonous character. An atmosphere containing only 2 per cent of the gas will prove fatal to animals breathing it; but, inasmuch as gas for illuminating purposes is meant to be burned, and not to be breathed, the question is not so much with regard to the poisonousness of the original gas as of the products of combustion. The amount of gas that escapes into the air unburned is so small that its presence may be safely disregarded.

Just one or two remarks with regard to carbonic acid. Carbonic acid gas is incombustible, and it has the property of extinguishing flame in a very remarkable degree. Further, a very small proportion of carbonic acid in coal gas lowers the illuminating power of the coal-gas flame to a great extent. It is estimated that the presence of 1 per cent of carbonic acid in coal gas will diminish the illuminating power of the flame by 5 per cent. Now, this is a very curious observation, and requires some further explanation, which I think the following circumstances may afford:—Carbonic acid gas at a high temperature undergoes decomposition. In the interior of any flame, carbonic acid ceases to be carbonic acid; it is decomposed into carbonic oxide and oxygen, so that in this way 2 per cent of carbonic acid gas is equivalent to 1 per cent of oxygen—or it may be said that 2 per cent of carbonic acid is equivalent to 5 per cent of air—and you know that an admixture of 5 per cent of air will lower the illuminating power of gas very much. In this case, a combustion takes place partially in the interior of the flame, instead of at the surface only; and by this interior combustion the luminosity of the flame is interfered with, in accordance with well-known principles. In order to obtain the maximum of luminosity, then, the admixture of oxygen in the form of air or of carbonic acid with the coal gas should be as little as possible. Where coal gas issues under a strong pressure, it gets mixed up with air to such an extent that the flame is scarcely more luminous than that of a Bunsen burner; and, from the decomposition of carbonic acid gas into carbonic oxide and oxygen, the carbonic acid contained in coal gas interferes with the luminosity of the flame in the same way as would an admixture of air.

Carbonic acid may be further considered, not only as a constituent of coal gas, but also as a product of its combustion. That it is produced by the combustion of coal gas we may readily ascertain. If we pour a little lime water into a flask within which a jet of coal gas has been allowed to burn for a short time, the lime becomes converted into chalk, by its absorption of the produced carbonic acid, and we get at once a milky precipitate, as you perceive. But carbonic acid gas is produced not merely by combustion, but also by respiration. If I breathe into this bottle, already containing

a little lime water, you see that I get at once a deposit of chalk or carbonate of calcium, just as in the last experiment of the burning gas-jet. Here a point of interest obviously arises in the consideration of the relative proportions of carbonic acid discharged into the atmosphere by the combustion of gas and the respiration of individuals. Time will not allow me to enter upon statistical details, but, speaking roughly, I may say that the air expired from the lungs contains between 3 and 4 per cent of carbonic acid, and it is calculated that one man in an hour produces about as much carbonic acid gas as a burner consuming 6 feet of coal gas, or as two burners consuming 3 feet each. So that when it is objected that any two burners in a room are producing so much carbonic acid as to affect the atmosphere injuriously, you may turn out your neighbour or turn out the gas with equal relief, seeing that he contributes quite as much carbonic acid gas as the couple of burners. Now, the ordinary proportion of carbonic acid gas in the atmosphere is under a half part in a thousand—it is about '04 per cent. The maximum amount that has been found in the gallery of a crowded theatre, for instance, where it may be assumed that the atmosphere is defiled to its utmost possible extent both by the combustion of gas and the respiration of individuals—each individual contributing as much as is produced by 6 feet of gas—has always fallen short of half a per cent, the highest determination made by Dr. Roscoe amounting to '32. Apparently, when the carbonic acid begins to accumulate to this extent, ventilation takes place through crevices and porous walls (for walls are freely porous to the minute particles of gases) whereby the proportion of carbonic acid is kept down, and, as I have just said, it has never been known to reach one-half per cent.

Now this observation has a very important bearing upon some other facts, to which I will refer in a minute or two; but there is, first, one other remark I have to make with regard to carbonic acid gas. It is a liquefiable gas. Under exposure to high pressure and low temperature it is converted into a transparent liquid; and, in its liquid state, it presents a most remarkable resemblance in its properties to that terror of gas managers, disulphide of carbon. Liquefied carbonic acid gas (CO_2) and disulphide of carbon (CS_2) are both of them heavier than and immiscible with water, but miscible with alcohol and ether; and they are both of them excellent solvents for fats, resins, india-rubber, &c. Further, in considering the properties of disulphide of carbon, we shall find that it acts as an anhydrous acid, combining directly with bases to form definite salts, strictly comparable with the ordinary carbonates produced by the direct combination of carbonic acid with bases.

(To be continued.)

ON NITROGLUCOSE.

BY M. CAREY LEA.

As nitroglucose has been much less studied than its congeneric nitro-substitution compounds, pyroxylin, xyloidin, and nitroglycerin, a few words on its preparation and properties may not be uninteresting.

The substitution does not take place in sugar with quite the same facility as with cellulose; the acids need to be stronger, and the temperature lower. The sugar, moreover, appears at first to dissolve, and then to separate out again in the form of a greyish paste, which,

when thrown into water and freed from the adhering acid, becomes nearly white.

An attempt to prepare nitroglucose by the use of nitre and sulphuric acid, which succeeds so well and so easily in the case of cellulose, failed almost wholly with sugar. Not more than two or three per cent of the weight of the sugar was obtained.

With sulphuric and strong nitric acids, allowed to cool thoroughly after mixing, the reaction takes place easily, and a considerable quantity of nitroglucose is obtained. The nitric acid should be as strong as possible, and as the acid of the requisite strength is not easily obtained commercially, I have found an advantage in using in part the fuming sulphuric acid. Two fluid ounces of fuming sulphuric acid, two of common sulphuric, two of strong nitric acid, as near to 1.5 sp. gr. as can be obtained, give good results. The sugar is stirred in, in the form of powder, to a thin paste. The stirring is kept up, and as fast as the nitroglucose separates in doughy masses, it is removed with a spatula and thrown into cold water. A further addition of sugar will give more nitroglucose, but considerably less in proportion than the first addition. As soon as possible, the nitroglucose is to be kneaded up with cold water, to get the acid out. In one case, when this was neglected for ten or fifteen minutes, the nitroglucose passed to a greenish colour, and apparently was undergoing a commencing decomposition.

The removal of the adhering acid is much more difficult than in the case of pyroxylin, and is an extremely disagreeable operation. The acid pervades the whole of the doughy mass so fully, that the fingers are stained and burned by it, nor can the whole of the acid be removed satisfactorily in this way. The best means I found was to dissolve the crude nitroglucose in a mixture of alcohol and ether, and then to pour this into a large quantity of cold water with constant stirring, and violent agitation afterward. The method is not altogether satisfactory, and seems to be attended with some loss of material, though why, it is not easy to see.

Prepared in this way, nitroglucose is a white lustrous body, which may either assume the doughy amorphous condition or the crystalline, and passes from one to the other with extreme ease. When first formed by the mixed acids, it always has the doughy form. That which I obtained by the use of nitric and sulphuric acid, was crystalline from the first. When precipitated by water from its solution in alcohol and ether, it is doughy and almost liquid, and remains so for a long time, if there is any considerable quantity of it.

The best mode of preserving it appears to be under water. By standing thus it gradually hardens, and passes sometimes to a somewhat hard amorphous mass, and sometimes to a granular crystalline state. It appears to be wholly insoluble in water. A few minute grains of the crystalline form diffused through 15 or 20 ounces of water, did not dissolve after many hours' standing. In a mixture of alcohol and ether it dissolves as easily as sugar in water, and in such quantity as to make the liquid syrupy.

Its detonating properties are but slight. If it be well dried and a match be applied, it deflagrates with a feeble flash.

It has been stated by Dr. V. Monckhoven that when dissolved in alcohol and kept some time in a warm place, it undergoes decomposition, as evidenced by the fact that the solution then gives an abundant precipi-

tate with nitrate of silver, which at first it did not do. An experiment made in this direction did not give the result thus indicated. A solution of nitroglucose in alcohol, containing about 40 grains to the ounce, was placed in a stoppered vial, and was kept in the sand bath at a temperature of about blood heat for nearly a month. But neither it nor a fresh solution gave a precipitate with alcoholic solution of nitrate of silver. It would seem from this that certain conditions of temperature or otherwise are necessary, in order that this decomposition should take place.—*American Journal of Science*, May, 1898.

ON SCIENCE TEACHING IN SCHOOLS.

BY GEORGE FARRER RODWELL, F.C.S.

THE subject of "Science Teaching in Schools" is at the present time receiving a good deal of attention, and it is undoubtedly one of the most prominent educational questions of the day. The ordinary school curriculum, although sanctioned by the usage of centuries, is about to undergo a profound change, indeed some of our public schools have already admitted innovations which are the horror of the more conservative masters. The chief feature of the contemplated change is the introduction of the study of at least two modern languages and of natural science into the usual school course. Hitherto, science, if taught at all, has been considered a supplementary subject, like music or Italian, to be taken up or not at the option of the pupil; as a necessary consequence of this no special portion of the school hours has been allotted to science teaching, and none of the ordinary studies have been omitted or abated. If the study of science is thus added to the usual tale of school work, it can be no wonder that apathy is so often exhibited in regard to it, and that boys are unwilling to increase their studies even by one which possesses the charm of novelty, and which appears at first sight to combine amusement with study.

The mode of teaching natural science differs considerably from that which is adopted with the subjects of the usual school course, because in the study of science it is possible to materially aid the subjective action of the intellect by objective means, while this is impossible in regard to classics, history, composition, &c. Natural science is capable of being taught in three different ways: (a) Individual study (by means of text books) directed by a competent master; (b) Collective study in the form of experimental lectures, supplemented by the writing of themes, and by examinations, both *vice versa* and written; (c) Practical work in a physical or chemical laboratory. Now it is undoubted that the best scientific culture can only be acquired by the simultaneous practice of these three modes of study, yet in discussing science teaching, lectures are frequently regarded as the only form of instruction possible in a school. No idea can be more erroneous than this; a sound knowledge of the least complex of the sciences cannot be efficiently acquired by simple attendance at lectures. Under any circumstances the study of the text-book should accompany the lecture-study, and if possible the student should have a certain amount of practical laboratory work. Natural science possesses an advantage over the subjects of the usual school course, in that it is based upon tentative action. The different parts of a connected process of scientific thought can, to a greater or lesser extent, be demonstrated by direct experiment, by which means a real-

ness of grasp and a facility of comprehension in this particular direction, is conferred upon the intellect, and it is rarely required to bridge over large unexplored tracts in passing from one generalisation to another. Each step in our rise to a generalisation should be an experiment, or a fact indubitably proved, and it is most essential that we ascertain the stability of the succeeding step before we quit that upon which we stand.

The amount of experimental illustration possible to different branches of science varies considerably. Pure mathematics is incapable of illustration, mixed mathematics sometimes admits of black-board illustration, but it is in applied mathematics that we perceive the dawn of experimental illustrations proper; then follow the more mathematical of the physical sciences. In the time of Newton optics would have come in here, but since the application of the electric lamp to optical experiments we must class optics with those sciences which admit of the most extensive illustrations,—that is with heat, electricity, acoustics, &c. Chemistry stands alone; from its very origin it has been based upon tentative actions. The alchemists and old chemists expended but little mind work upon their labours; they had no problems to solve, or theories to elucidate, and their work was essentially tentative, hence the early rise and rapid development of an extensive experimental system in chemistry. Geber, who lived in the eighth century, could have given (and probably did give) a well illustrated course of chemical lectures; he could not, indeed, have produced acetylene by synthesis, or have illustrated the properties of zinc-ethyl, but he could have shown many of the processes which are in daily use among chemists,—distillation, sublimation, calcination, &c., and the preparation of many familiar acids and salts. It is impossible to read his treatise "*De Summa Perfectioni*," without feeling convinced that chemistry was by no means new-born a thousand years ago, indeed there is strong evidence to show that nitric acid was known to the Egyptians at least two thousand years before the time of Geber.

The first great impetus was given to the experimental illustration of physical science (as distinguished from chemistry), by the members of the Accademia del Cimento, whose elegant and refined experiments have not yet ceased to be quoted in text-books and practised in lectures. The perusal of the "*Saggi di Naturali fatte nell' Accademia del Cimento*," cannot fail to strike us with the ingenuity in contrivance, the skill in construction, and above all the delicacy of manipulation of the Florentine Academicians. Before the foundation of the Academy in 1657, physical experiments were extremely rough and clumsy, as may be seen by reference to the "*Historia Macrocosmi*" of Robert Fludd, or to the "*Norma Organum*." Pascal, Hooke, and Boyle did much to further the means of physical illustrations. During the last years of the seventeenth century a well illustrated course of lectures on pneumatics might have been given, but I do not think that this could have been done in regard to any other branch of science. A few lectures sparsely illustrated might have been given on dynamics, hydrostatics, and hydrodynamics. In 1730 Francis Hauksbee, a philosophical instrument maker, living in Crane Court, Fleet Street, supplied the apparatus, and acted as demonstrator of a course of twenty-six lectures on natural science; it is instructive to note the nature and division of the subject matter. The syllabus, which consisted of twenty pages of text, and twenty full page plates, served at the same

time as a catalogue of Hauksbee's apparatus; it is entitled, "A course of mechanical, optical, hydrostatical, and pneumatical experiments, to be performed by Francis Hauksbee, and the explanatory lectures read by William Whiston, M.A."

The subject matter was divided as follows:—

Mechanics.....	seven lectures.
Optics.....	five "
Hydrostatics.....	three "
Pneumatics.....	eleven "

The lectures appeared to have been well illustrated; the terms were two and a half guineas for the course. I am inclined to imagine that this was the most extensive and best illustrated connected course of lectures which, up to this time, had been delivered in England.

In 1720 the first comprehensive text-book of physics was published. It is entitled, "*Physices Elementa Mathematica Experimenta Confirmata*," and it was the work of the celebrated S'Gravesande.* The third edition of this work (published in 1742) consists of two quarto volumes, containing no less than 127 full page plates, and 1,073 of letter-press. Much of the apparatus described is in use in the present day, and the plates may always be consulted with advantage. The work contains a complete account of the physical science of the period, exact mathematical treatment being introduced whenever it is possible. The sciences treated of are statics, dynamics, hydrostatics, hydrodynamics, pneumatics, optics and astronomy. Heat, acoustics, magnetism, and electricity are very briefly alluded to, for at this time none of these subjects (perhaps excepting magnetism) had arrived at the dignity of a science. Among the intimate friend of S'Gravesande was Peter Van Musschenbroek, who founded a chair or physics at Leyden, and it is to a great extent to these two men that Europe owes the introduction of the Newtonian physics into her universities and schools. Musschenbroek was Professor in the University of Utrecht from 1723 till 1735, during which he translated the "*Saggi di Naturali esperienze fatte nell' Accademia del Cimento*" into Latin, and at the same time he added a number of experiments of his own, chiefly in the form of notes to supplement the account of the Florentine experiments. The translation is prefaced by an oration, "*De Methodo Instituenti Experimenta Physica*," which Musschenbroek delivered before the University in 1730, and which contains much valuable and suggestive matter. A singularly elegant passage (albeit it is couched in the florid Latin of the period), occurs in the opening address of this oration. Beginning with "*Amplissimi Nobilissimi*," he addresses himself to the professors of the University, the clergy, the doctors in all arts and sciences, and the citizens; then to the students he says:—"Tu denique lectissima studiosae juventutis corona, spes patriæ, parentum gaudium, noster amor."

In connection with the teaching of physical science let us not forget John Christopher Sturm,† who was thirty-five years Professor in the University of Altorff, "*Ubi*," says his biographer "*mathesin et physicam cum laude et applausu docuit*." He did much to cultivate a taste for experimental science in Europe, and to prepare the way for the labours of S'Gravesande, Musschenbroek, and Boerhaave, who like him were zealous propagandists. Sturm must ever be remembered with

gratitude as one of the first professors in Europe, "*Physicam scientiam juxta cum mathematicis publice docere*."

Shortly after the publication of S'Gravesande's physics Boerhaave (who was also a Leyden professor) published his "*Elementa Chemiae quæ anniversario labore docuit in publicis privatisque scholis*." This work appeared in 1732 in two quarto volumes, and it did for chemistry that which S'Gravesande had done for physics; it was the first comprehensive work on the subject, and served for many years as the chemical text-book of Europe.

The University of Leyden must ever be remembered with respect by the student of science. If it were alone for its associations with that great triumvirate—S'Gravesande, Musschenbroek, Boerhaave,—it would be entitled to our grateful memories. From it emanated the two first text-books of experimental science; the discoveries of its professors pervade our treatises; its students, who flocked to it from all parts of Europe, carried back to their native countries the love for experimental science with which they were smitten; in it science has always found a home, and a loving, watchful, indulgent parent.

For many years after the time of S'Gravesande natural science found but little favour in our own universities, and was altogether untaught in our schools. A great impetus was given to its study by the discoveries of oxygen and of chlorine, the improvements added to the air-pump and electrical machine, the discovery of voltaic electricity, and the brilliant application of it as a decomposing agent by Sir Humphry Davy. The Royal Institution lectures have done much to diffuse a love for experimental science. It is only during the last thirty years that science has asserted itself as an educational engine in this country; it has year by year been taught more fully in the universities and medical schools, and the time has at length arrived when by general consent it is to be diffused throughout the length and breadth of the land by its introduction into schools. It is now to form a part of a liberal education; some would make it the basis of a liberal education, but they err greatly not knowing the precise nature of the study. Science is too exact and rigid to engage the attention of the young pliant mind with all knowledge before it. It is a study which does not educate the intellect in matters of taste, or style, or literary elegance. Holmes has well said, "Scientific knowledge, even in the most modest persons, has mingled with a something which partakes of insolence. Absolute peremptory facts are bullies, and those who keep company with them are apt to get a bullying habit of mind;—not of manners perhaps. . . . Take the man for instance who deals in the mathematical sciences. There is no elasticity in a mathematical fact; if you bring up against it, it never yields a hair's breadth; everything must go to pieces that comes in collision with it. . . . Every probability—and most of our common working beliefs are probabilities—is provided with buffers at both ends, which break the force of opposite opinions clashing against it; but scientific certainty has no spring in it, no courtesy, no possibility of yielding. All this must react on the minds which handle these forms of truth." Fully endorsing every word in the above extract, I say that science can never be the basis of a liberal education; neither should it be taught in any but a highly experimental non-theoretical form to the lower classes of a school. But when the student is more advanced, when his mode

* Born 1688; made Professor of Astronomy and Mathematics in the University of Leyden in 1717; died 1742.
† Born in 1635; died at Altorff (in Franconia) in 1703.

of thought has been methodised and syncretised in certain directions, there can be no doubt that the study of science is most efficacious as a producer of exactness of thought and accuracy of perception, and of keen observant habits of mind.

It being admitted that the study of natural science in schools is desirable, the next question which presents itself is how it may be most efficaciously introduced. I do not think that it would be wise to add this new study without at the same time diminishing the time devoted to some of the present studies. We must feel our way: a portion of two days in each week is amply sufficient for science teaching, and such lessons may perhaps most advantageously replace a portion of the mathematical training. Natural science and mathematics have so many points of contact that they may be assimilated as much as possible. Francis Bacon has well said, "*Optime autem cedit inquisitio naturalis, quando physico terminatur in mathematico.*" The work of science teaching would perhaps be best accomplished by a resident master whose labours should be supplemented by one or more of the mathematical masters. I strongly dissent from the opinion expressed by Mr. Oscar Browning in an able and suggestive article as to the mode of teaching*:—"A system of itinerant lectures," writes Mr. Browning, "to great schools by great men, would be a powerful educational engine. . . . The sight and voice of great discoverers may fertilise latent germs of kindred genius." Now I venture to assert that such a method of science teaching would be of far too excitable a character to be productive of serious and calm study. If an exciting cause is necessary to induce the study, it would often happen that the latter would be discarded when the former disappeared. Schoolboys would become so *blasé*: that eloquent Professor A—— would have an audience of five hundred while the less eloquent but equally learned Mr. B—— would have to content himself with a score, just as the Parisians flock to hear Père Hyacinthe while they leave the godly Curé of Notre Dame de Lorette with an empty church. Unless science recommends itself by its own beauty, I think it unwise to tempt boys by such factitious means. The study must be taken up willingly, and the mind of the pupil must be more or less assimilable with the mode of thought required, or the teaching (especially such excitable teaching) is useless. It appears to me that the very principle is wrong. Many a man who would fail to distinguish between the tenets of Anselm and John Huss would devote himself to doctrinal divinity if the Archbishop of York would be his teacher; or again the most unmusical individual would willingly give up every moment of his spare time to music if Rossini would be his master, and La Lucca would sing to him, and Joachim be his accompanist. Nay, I will go a step farther: are there not many to whom the very names of Poinset, Fermat, and Laplace are all unknown, who would devote themselves to curves fulfilling the equation—

$$\frac{d_2 p}{dx_2} + \frac{d_1 p}{dy_1} = 0$$

if Sylvester or M. de la Goupillière would instruct them? But in each of these instances the action passes off from love of the subject to admiration of the teacher. Unless the student has some special subjective affinity with that which he studies, he can never excel in it, never thoroughly master it. If science is to be introduced into

our schools, it must be studied calmly, soberly—ay, reverently, and without factitious advantages, for she is a modest maiden in a russet mantle, not a gaily dressed woman of the world. "The sight and voice of great discoverers 'might indeed' fertilise latent germs of kindred genius," but I think if the germs of genius were already in the student they would assert themselves without such inducements. There is certainly an attractiveness in peculiarity of diction, unusual phraseology in style, mode of expression, even in voice and action; but what said the older rhetoricians of some of these practices? Gorgias, the Sophist, did indeed advocate them, but we may willingly allow the use of a meretricious rhetoric to the man who made it his principal object to demonstrate that nothing exists, and that nothing can be known.

Many will enquire the object of teaching natural science in schools. I say it is to be regarded as a particular kind of mental training, as the inducer of an exact and discriminative mode of thought which attains its highest development in the pure mathematics, and which just dawns in the classificatory sciences, such as botany, &c. I do not think that the classificatory sciences can be taught with advantage except to very young boys. In pure mathematics each step is gained by intellectual action, while in the classificatory sciences memory is more important than intellectual action. Experimental science partakes of both, but it is happily placed nearer to the purely mathematical than to the classificatory sciences. The object of science teaching has been variously defined. "Different branches of science," says Mr. Browning, "are admirably suited to be applied as alternatives to the jaded mind, and to excite the appetite for knowledge which may have been dulled by application to the regular studies." I must again protest against this view of the object of science teaching. Surely natural science is a study too noble to be allotted to "jaded minds," to refuse mental action—too full of dignity to be used as a spice to excite the literary appetite in a direction remote from itself. Science rightly demands of her followers clear, bright, fresh intellects, unfettered in their action, and devoted to her interests, and if the study is to be introduced into our system of education it is only under these conditions that it will flourish.

One word in conclusion on the subject of education in general. It appears to be the fashion just now to abuse some of our high class schools and our whole system of education. Whenever an educational debate takes place in the House of Commons we may be sure that some member will bring in the fact that when he was at Eton, or Winchester, or elsewhere, he learnt "*nothing*," and on that account he condemns the entire school system. But side by side with him in the school were there not men who in after life shone at the Universities, at the Bar, in public life? They evidently learned something, albeit they were placed under the same circumstances as himself, at least there was the opportunity of learning, and the fact of learning nothing would seem to tell rather against the individual than against the school or the system. But even if he learnt nothing of ordinary book work, he learnt much that forms part of a liberal education and which is essential to him as a man, but for which he gives the school no credit:—a gentlemanly tone and character, a facility of intercourse with his fellows, a modus of routine, a manly masterful spirit, a sense of honour, a knowledge that he must hold his own, and fight his own way in the world, and a certain *esprit de corps*

* Vide CHEMICAL NEWS, No. 442 (*Am. Repr.*, July, 1868, page 17).

which remains with him through life. It is too trite to remark that a school symbolises and typifies the great world of human beings without. The world is a macrocosm, the school is a microcosm. In the latter there are the same struggles against opposing causes, the same oppression to be resisted, and wrong to be avoided as in the former; the same striving to attain, the same right principle to be maintained, and obedience and respect to be rendered; the same exhibition of passions, feelings, hopes, aspirations, the same bestowal of brotherly love; while pervading all, sanctifying all, binding all together into one harmonious whole is the great maxim, "Fear God, honour the king." Then there is that veneration of all that is ancient, that intense admiration for the patriotism and valour which in former ages ennobled dynasties, and raised mere specks upon the earth's surface into powerful states governing half the world; in our schools we are surrounded by these influences, and we imbibe them and carry them to our graves. Is it nothing to learn these things? The different portions of educational work—classics, composition, history, natural science, &c.—are but separate tools which are used to perfect the form of the intellect. At first it is often of an ungainly form, rugged, and misshapen; the joint of many tools can alone bring it to a perfect form.

I say then we must not judge our educational system by the actual *knowledge*, in the ordinary acceptance of the word, which is acquired at school. The formation of an elegant, appreciative, and discriminative taste must ever be the main object of a liberal education; hence it is that I deprecate the introduction of *applied science* at least into our public school curriculum. If science is taught at all it behoves us to teach the purest form of it. I see nothing elevating or improving to the intellect of a boy in the knowledge of the modes of utilising tar liquor, or of dying calico. Science has a higher object than this to perform in our educational system, as a mind former, as the completer of a certain phase of brain action, and the cultivator of scrutiny, of accuracy, of connected thought, and legitimate generalisation. If there be nought that is elevating in applied science, truly there is much in pure science. Under her guidance we may trace a force throughout the universe, and note the eternal resolvability of its form; we may visualise the sea of ether with its waves ever dashing upon us, now gladdening all things in the form of light, anon vivifying the universe in the form of genial heat.

NOTES ON CERTAIN ABSORPTION SPECTRA.

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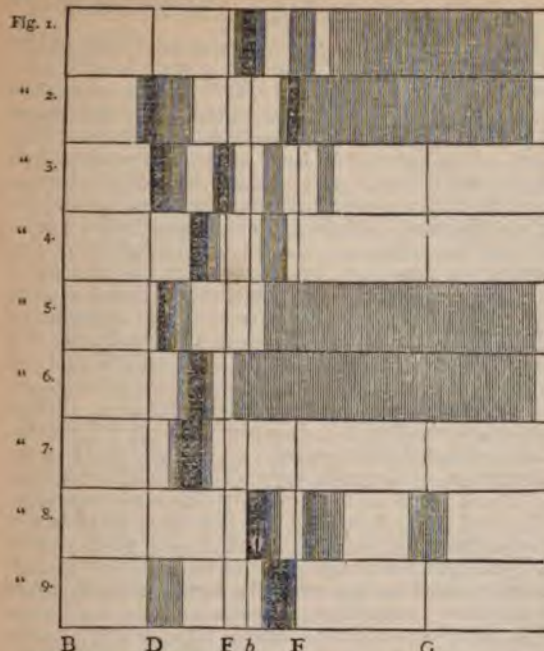
THE following notes are the result of some observations made during the past four years, on the manner in which certain coloured liquids act on transmitted light. This subject has already received much attention from the late Sir David Brewster, Sir W. Herschel, Dr. Gladstone, and others; but it remained for Professor Stokes, of Cambridge, to give it an unusual degree of interest by the use of the spectrum analytical method in his valuable researches on the colouring matter of blood. Still more recently Mr. Sorby has applied the spectroscope to the microscope, and thereby materially facilitated the accurate investigation of minute blood stains or other coloured spots.

In the present paper are noted cases in which I have applied the method of spectrum analysis as a sort of crucial test of the tenability of certain received opinions. I have also used it in examining the murexides and some of the coloured woods; the latter more particularly with a view to determine certain points relative to their colorific principles, and to their detection when used as adulterants in spirituous solutions. On the latter point much has been already written by others, and little can be added to that which is now well known, nevertheless I give my notes on the subject, as they were made at a time when a very small share of attention had been given to the matter.

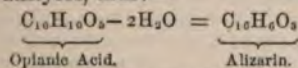
The apparatus which I employ consists of a small pentagonal box, in one side of which is fitted a brass tube, about eight inches long; at the free end of the latter is placed a slit, adjustable by means of a screw, and at the other extremity a plano-convex lens is so arranged that the slit shall be in its principal focus. The rays of light, transmitted by the aperture, are rendered parallel by the lens, and then pass through a bisulphide of carbon prism (refracting angle = 59°), firmly fixed in the box. The spectrum of the light examined is then seen on looking through the second face of the prism. If the apparatus be pointed at a bright cloud, and the slit adjusted, the chief solar lines of Fraunhofer can be easily seen with the naked eye. When the light is made to pass through a coloured liquid contained in a test tube, and the latter placed before the slit, we most conveniently observe the characteristic absorption spectrum of the substance examined. Professor Stokes has already fully drawn attention to the distinction to be made between the production of characteristic bands in the spectrum and the mere absorption of certain colours. In some cases this is a question of dilution; in others, where no bands are developed under any circumstances, the complementary colours are then simply wanting. Thus, permanganate of potassium, when in dilute solution, gives five beautiful absorption bands in the green; but, if the liquid be concentrated, the centre of the spectrum is cut out, but no bands are observed. On the other hand, the purple colouring matter of most flowers, when in strong solution, produces almost the same degree of general absorption as the permanganate; but, if diluted, no bands are apparent, the centre of the spectrum being then merely weakened.

It is curious to remark, in examining the nature of the light transmitted by coloured solutions, the inverse relation sometimes observed to exist between the absorptive effect which a given liquid exerts on the spectrum and the intensity of its colour. We are all familiar with cases of very dilute and slightly coloured solutions, such as those of permanganate of potassium, or nitrate of didymium, which give rise to characteristic and strongly marked bands, but cases the reverse of these are not often met with. In the colouring matter of the common blackberry, however, we find a body which, under different conditions, will exhibit either phenomenon; but it must be premised that no distinct bands are produced. If an aqueous solution of the colouring matter be examined with the spectrum apparatus, the liquid, though of a pale purplish red tint, will be found to absorb very strongly the central portion of the spectrum, commencing near η , and shading off near ϵ ; in rather dilute solutions a trace of a band may be distinguished on the confines of the least refrangible end of the dark space. With the alcoholic solution, however, the case is different: its colour is a

magnificent purple, and much more intense than the aqueous decoction; but its effect on the spectrum is very much less marked, though the light actually absorbed is of nearly exactly the same degree of refrangibility as in the first instance.

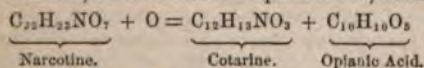


Coloured Derivative of Opianic Acid.—By dehydrating opianic acid, Professor Anderson produced a colouring matter undistinguishable chemically from madder alizarin. On removing four atoms of water from the acid we get the formula of alizarin according to the best analyses, thus:—



This was a case, therefore, peculiarly suitable for examination by the optical method.

Opianic acid was prepared by Matthiessen and Foster's process, *i.e.*, by the action of manganic oxide on narcotine. This base, as is well known, gives rise, when oxidised, to cotarine and opianic acid, thus:—



The pure and dry acid was dissolved without heat in some concentrated sulphuric acid, and the solution allowed to stand. Gradually the liquid became coloured, and simultaneously bands appeared crossing the spectrum of the transmitted light. The maximum of clearness and intensity was reached after four hours' standing at the ordinary temperature, and continued for several days.

The spectrum observed is shown at Fig. 2; it is marked by a very dark band on *v*, sharp at its least refrangible side, but shading off into the green. Another band on *r* can be seen, but it is not well marked, since the rest of the spectrum is almost wholly cut off beyond this point. In addition to the bands and shading, strong red fluorescence was observed. This colouring matter likewise gives the madder tints with

mordants; but these compounds do not present any characters worthy of special notice.

When the spectrum of Anderson's alizarin is compared with that of the true madder alizarin, under like conditions (see Fig. 1), it will be seen how thoroughly distinct they are in optical properties, though so nearly identical in their chemical relations.

Rufigallic Acid.—The striking parallelism in many physical and chemical properties known to exist between madder alizarin and rufigallic or parellagic acid rendered the comparison of the absorption spectra of the two bodies, under similar conditions, a matter of considerable interest.

Rufigallic acid was prepared by digesting a solution of gallic acid in five times its weight of concentrated sulphuric acid at a gentle heat for a sufficient time. The purple-red liquid was then slowly poured into a considerable quantity of cold water. A brown flocculent deposit was thus produced; this was collected, washed with boiling water, and dried. Repeated resolution in sulphuric acid and precipitation by water rendered this pure. With alkaline carbonates and alum, dull purple liquids were obtained. By careful sublimation the powder may be made to yield beautiful orange-yellow crystals, very strongly resembling alizarin of madder prepared by a similar process. As in the latter case, a large portion of carbonaceous residue likewise remains behind.

When the light transmitted by a sufficiently dilute solution of rufigallic acid in oil of vitriol is examined with a prism, the very characteristic spectrum represented at Fig. 3 is observed. The two least refrangible bands are those most strongly marked when the sun is the source of light; while the remaining two, of higher refrangibility, are only easily observed with artificial light. It is curious to remark here, that if a very weak sulphuric solution of the rufigallic acid be heated sufficiently, the absorption bands disappear, but become again visible as the liquid cools.

The solution of the acid in carbonate of sodium is reddish brown, and simply cuts off the most refrangible portion of the spectrum, commencing at *e*; with ammonia a dirty purple-red liquid, which weakens that portion of the spectrum more refrangible than *r*. Alum gives with rufigallic acid a solution of a fine purple colour, which absorbs much light between *v* and *r*, leaving both ends of the spectrum clear. These reactions are remarkably different from those afforded by madder alizarin.

A similar series of experiments was made with the crystalline sublimate obtained from the amorphous rufigallic acid, but the results were identical with those just described; we may therefore state that rufigallic acid sublimes unchanged.

Murexides.—The uric acid and caffeine murexides are so closely allied in chemical constitution, as well as in many of their physical properties, that it appeared to be a matter of interest to compare the action of the magnificently coloured aqueous solutions of each body on transmitted light.

Uric acid murexide was prepared by the action of ammonia or a mixture of alloxan and alloxantin, and the caffeine derivative by treating amalic acid with ammonia. The prismatic analysis of the light transmitted by the aqueous solution of each did not show any marked difference in their optical properties. In both cases the spectrum was found to be much weakened in the green, but no bands were observed. On the addition of a little hydrate of potassium, the solution

of uric acid murexide changed to a violet tint, but its action on the spectrum was not very perceptibly altered. A mineral acid discharged the colour from the original liquid. The solution of the caffeine compound, on treatment with hydrate of potassium, is simply weakened in colour, but it does not absorb light differently. The presence of a free acid does not diminish the intensity or alter the tint perceptibly.

It was found, in prosecuting these experiments, that when either murexide was prepared by a process different from those above-mentioned, that product exerted the same action on the spectrum, but the relations to reagents were materially altered. We therefore learn that the two murexides remarkably resemble each other in optical as well as in general characters; so that, when prepared by similar methods, they do not differ from each other in any important point more than will two samples of the same murexide, when both have been produced by different processes.

I may now mention a curious result obtained when applying the murexide test in a peculiar way to a solution known to contain pure caffeine. The liquid was acidulated with hydrochloric acid, warmed, and then a crystal of chlorate of potassium dropped in; after digesting for a sufficient time, the whole was allowed to cool, and some strong solution of ammonia carefully poured into the test-tube, so that the column of specifically lighter liquid might float on the test solution. This was then left at rest for twenty-four hours, at the end of which time the two liquids were found to have partially mingled, and produced a purple-red solution, which on prismatic examination was observed to cut off two sharp bands in the spectrum, as represented in Fig. 4. May we not infer from the results of these experiments that uric acid and caffeine are each capable of yielding several different coloured products?

Logwood.—The light transmitted by the aqueous decoction of the wood of *Hæmatoxylum Campechianum* when analysed by the prism gives the peculiar spectrum represented at Fig. 5. This shows a strongly marked absorption band but little more refrangible than the solar line *b*, the side next to the fixed line being sharply defined, but the second edge shades off gradually to near *e*. A very marked diminution of light is observed in the higher portions of the spectrum, commencing about *f*; the intervening green space is also somewhat obscured. With carbonate of ammonium the solution is of purple-red colour, but the band beyond *b* remains unchanged; a new band, however, appears, rather faintly marked, midway between *b* and *f*; the remaining portions of the spectrum are much less weakened than in the last case. When the solution of the colouring matter is warmed with alum, the band near *b* is alone apparent, the rest of the spectrum being nearly free from shade, with the exception of a slight absorption, extending from the least refrangible edge of the band to midway between *c* and *d*; this is the point from which all light is observed to be cut off in the very strong solution. These are the most striking reactions of the aqueous decoction. The alcoholic tincture of logwood is pale yellow, and simply absorbs the blue rays from about *b*, leaving the remainder of the spectrum unchanged. If to the alcoholic liquid a drop of caustic ammonia be added, a magnificent purple-red colour is produced; this solution gives the single absorption bands just beyond *b* very strongly marked, and leaves both ends of the spectrum perfectly clear and bright. In weak spiritu-

ous solutions of the colouring matter other chemical agents react in nearly the same way as in the aqueous decoction.

Pure colourless hæmatoxylin ($C_8H_{11}O_3$), when allowed to oxidise by contact with the air affords a solution which reacts in precisely the same way as the aqueous infusion of the dyewood.

Brazil Wood.—The aqueous infusion of the wood of the Lima variety of *Cæsalpina crista** is of a pale brownish yellow colour, and acts in a remarkable manner on the light which it transmits. Fig. 6 represents the absorption which it produces in the spectrum. The first or least refrangible band is strongly marked, but the second is lighter, and rendered less evident by the considerable weakening of the spectrum beyond it. The addition of a dilute acid but little alters the colour of the solution; but, on examining with the prism, it is now seen to produce but one ill-defined band, intermediate in situation between *b* and *e*. On the addition of a small quantity of caustic ammonia to the infusion, the liquid changes to a fine ruby-red colour; it then absorbs the single band on the confines of the green, as represented in Fig. 7, while both ends of the spectrum are perfectly bright and clear. When alum is warmed with the aqueous infusion, the characteristic bands before apparent are replaced by a general absorption of the green rays. The alcoholic tincture of Brazil wood affords precisely the same reactions. Chevreul was, I believe, the first to separate a red crystalline substance from Brazil wood; to this body he gave the name *Brazilin*, as he supposed it to exist ready formed in the tree. Preisser, however, some years later, showed that colourless crystals can be obtained from the alcoholic extract by agitating it with hydrate of lead and subsequently decomposing the resulting compound with hydrosulphuric acid. The colourless substance so prepared he named *Brazilin* ($C_8H_{11}O_3$), and Chevreul's red compound *Brazilein* ($C_{18}H_{22}O_7$). Notwithstanding the doubts entertained of the accuracy of Preisser's statements, I must say that I have succeeded in preparing a nearly colourless substance from Brazil wood by Preisser's process, which, when dissolved and treated with ammonia with exposure to the air, gave a coloured solution which acted upon transmitted light in a similar manner to the ordinary infusion of the wood. Of course the corroboration of Preisser's results in this direction in no way affects the objections which have been taken to his formula by Watts and others.

Camwood, or Barwood.—The absorption spectrum afforded by the alcoholic solution or infusion of camwood is very remarkable on account of the considerable refrangibility of the bands which characterise it. Fig. 8 represents the appearance which we observe on examining the light transmitted by such a solution with the prism. It will be remarked that, in addition to the bands situated in the green and blue spaces, a slight shading on *c* is perceptible. If to the alcoholic liquid we add a drop of strong ammonia, the solution becomes of a dull purple-red colour, but gives the peculiar spectrum shown at Fig. 9. The first and least absorption occurs a little beyond *b*; the second band is strongly marked, but its borders are ill-defined. Potash acts in a similar manner. When boiled with the addition of a single drop of strong alum solution, the two bands of the simple alcoholic tincture are destroyed, and replaced by a shading of the spectrum

* Pernambuco wood gives similar reactions.

between *e* and *f*. If to the original liquid a few drops of dilute nitric acid be added, a similar result is obtained; but in this case the absorption takes place between *d* and *e*.

ON THE DISTILLATION OF HYDROCARBONS.

BY JOSEPH HIRSH, PH.D.

ON reading the note of Prof. B. Silliman, on his "Examination of some California tar,"* it occurred to me that similar experiments, when carried on with a view of ascertaining the qualitative and quantitative result of illuminating oil, should be executed under circumstances more parallel to the distillation on a large scale, in order to arrive at an approximately true result.

During distillation of natural hydrocarbons on a commercial scale, i.e. in large stills, the process of "cracking" always takes place to some degree; or, in other words, as all native hydrocarbons consist of mixtures of those substances of greatly varying boiling points, all hydrocarbons of high boiling points contained in such mixtures are during distillation exposed to various degrees of temperature below their own boiling point, as long as those hydrocarbons of lesser gravity and lower boiling point have not been removed by distillation.

It is this exposure to a lower degree of heat than corresponds to the distilling point of an oil of definite gravity which comprises the operation of "cracking." If we consider that the stills used ordinarily in this country vary in capacity from 500 gallons to 20,000, and in single instances, as in the refinery of Reese and Graff, Pittsburgh, Pa., to 40,000 gallons a piece, the discharge of which varies in duration from one to six days, it will be evident that frequently, as in the last case mentioned, a portion of the oil, which may enter the still with a boiling point of, for instance, 400° F., will remain exposed for more than 100 hours to various degrees of increasing heat, all of which are below its own boiling point, as the heat of even the strongest fire is absorbed by the evaporation of the more volatile portions of hydrocarbons.

During this normal state of distillation in a still of such dimensions, the process of "cracking" will be taken advantage of in a supreme degree without any especial efforts or loss of time, the resulting distillate being of a light specific gravity and corresponding colour, while only a small portion distils over as paraffin oil, the latter being due to over heating, which with a small quantity can hardly be avoided in so large a still, on account of the peculiar shape which has to be given to it to insure sufficient strength, and the effect upon that of the fire. To this point I shall return again.

If we compare the distillation of 5 or 10 gallons with the above we find that in applying fire freely, the entire quantity may be distilled off in less than an hour, and cannot likely take more than a few hours—referring, as before, to a moderately intense heat. Here, according to the construction of the still or the manner of applying heat, the distillate will contain hydrocarbons of as high a specific gravity respectively, and as high a boiling point, as the crude oil did before entering the still, or even of a higher one, if the oily vapours were over heated.

In this case the two leading items in the distillation on a commercial scale, viz., time and a temperature be-

low the actual boiling point of a portion of the oil, are entirely wanting, and their absence unavoidably greatly modifies the resulting product. If, then, we wish to distil a small quantity of hydrocarbons analogous to the manner in which this process is carried on on a large scale, we have to employ the process of "cracking" only. But even then very rarely has the time of executing such a distillation of a few gallons been extended beyond a small number of hours, and the consequence is a distillate with a comparatively high boiling point.

The difference between this last named distillation and that on a large scale is the same as the one between distilling coal for the production of illuminating gas and that for producing coal oils. The former, producing tar of great specific gravity, is, for the reasons mentioned, even on a large scale, carried on in comparatively small low retorts, while for the production of coal oils, the larger revolving retorts are found more desirable. In these, the oily vapours are exposed to a cooler temperature than their own, with every revolution of the retort, and are in this manner broken up into oils of lighter gravity, distinguished from the tar oils by their fitness for illumination.

If, then, a few gallons of hydrocarbons are distilled with a view of presenting the probable results on a large scale, we ought to consider the amount of heating surface, which ought to be small, and only at the bottom of the still, together with the arrangements made for cooling the sides and upper portions of the distilling apparatus, as this materially influences the process of "cracking."

This may be more comprehensible by noticing the rules which by experience I found to regulate the distillation of carbon oils on an extensive scale.

1st. The difference of temperature between the actual boiling point of oil of definite gravity, and of the temperature to which it is raised, is proportionate to the effect of the process of "cracking," i.e., the more the temperature of the actual boiling point of oil of definite gravity is above the temperature to which the same oil is raised, the greater is the quantity of light oil obtained. If then we wish to reduce the gravity of a very heavy oil greatly, we shall have to employ an exceedingly low temperature, so low sometimes as to suspend actual distillation for a short time.

2nd. The gravity of the distillate, resulting from reduction of temperature, will be directly proportionate to said reduction, i.e., if we reduce the temperature to a degree at which only naphtha of 0.700 boils, the resulting distillate will possess a specific gravity of 0.700 regardless of the gravity of the original oil.

This law enables us to produce a distillate of any desired gravity (below that of the oil before distillation) from any crude oil, and a due regard to it enables us to produce an illuminating oil of the same specific gravity without great quantitative loss from the light Pennsylvanian oils, as that produced from the heavier Ohio, Canada, or California oils. In distillation the temperature therefore should always be reduced to the boiling point of oil of the specific gravity desired.

3rd. The difference between the temperatures of the two boiling-points, viz., of the oil being subjected to distillation, and of the desired distillate, is in direct proportion to the height of the still employed, or, which produces the same effect, to the facility for cooling the upper portions of the still. According to this law a heavy oil will yield the readier a light distillate the higher its vapours have to rise before leaving the still,

* CHEMICAL NEWS, No. 436, p. 171 (Am. Repr., June, 1868, page 257).

because the reduction of temperature in those higher portions of a retort which are more remote from the source of heat acts upon the vapour of the oil in fine division, and reduces their gravity more readily than the compact liquid oil.

If the heat is applied solely to the bottom of the still, while its sides and top may be exposed to a current of cool air, the reduction of temperature of the oil vapours takes place similarly to, and can be controlled better than, the cooling in high stills without this provision.

The arrangements for cooling the sides and top of a still must therefore be the more complete the lower or smaller the still employed is. This law also teaches us that stills to be used for "cracking" oil should have a flat bottom, and should have the flues arranged in such a manner as to permit the restriction of the fire to the bottom only, which is necessary to the process of "cracking."

Where superheated steam is used as the heating medium it ought to be applied at the bottom only. Where the dimensions of a still become as huge as was mentioned in the beginning of this article, a flat bottom would hardly be strong enough; in this case the boiler shape is usually employed. In order to have a practically sufficiently large heating surface, the fire here has to reach up to a certain distance on the round boiler. If the quantity of oil present in the still is so small as to be below the boiler surface exposed to the fire, the raising oil vapours will be superheated on this surface, and the resulting distillate will be of greater specific gravity, and of darker colour than it normally would have been, the product resembling more the oils resulting from the distillation of coal-tar.

For this reason the residuum in such stills, after reduction to the quantity mentioned, is frequently removed to smaller stills. This diminution of temperature of the oil vapours causes a partial condensation and redistillation of the oil, which diminishes the colour and gravity of the oil.

4th. The intensity of the process of "cracking" is proportionate to the suddenness with which the oil vapours are condensed before leaving the still. The thorough application of this principle produces more rapidly those results mentioned as necessary in the preceding paragraph.

5th. The difference in gravity between that of the oil distilled and of the desired distillate is in direct proportion to the quantity of water produced in the process.

If from a very heavy oil an exceedingly light distillate is to be produced, the proportion of water is so immense as to show occasionally a distillate of water with but a minute percentage of oil floating on its surface. In all such cases small black particles of carbon float on the top of the water, forming an intermediate layer between the latter and the oil. The quantity of carbon separated in this manner is also proportionate to the quantity of water distilled over resp., to the intensity of the process of "cracking" employed. This carbon is mechanically carried over by particles of water, which in contact with oil always produce violent ebullition.

These laws are the same with hydrocarbons distilled under the ordinary atmospheric pressure as with those distilled in a vacuum or under increased pressure. In the two last-named cases the variation of boiling point corresponding to these different degrees of pressure has to be taken into consideration.

Referring once more to the article of Prof. Silliman,

I would mention that I deem his concluding assertion—"The transformation of light oils into denser products like tar, to result not as has been supposed by some, from the addition of oxygen producing an oxidised body, but by the removal of successive atoms of hydrogen in the form of water,"—simply a different mode of expressing the opinion of others referred to, as the removal of hydrogen in the shape of water is certainly a perfect and true process of oxidation.

Western Chemical and Starch Works, 201 and 203 South Water Street, Chicago, June 24th, 1868.

ON A NEW ALKALOID CONTAINED IN COMMERCIAL ANILINE AND ISOMERIC WITH TOLUIDINE.

BY M. ROSENSTIEHL.

By the transformation of the toluol of coal tar into toluidine a non-crystallisable alkaloid is obtained. This has been remarked by several observers—amongst others by MM. Coupiér and Graefinghoff; the latter explains the fact by admitting that toluidine may exist under two modifications, one liquid, the other solid, but he points out no other distinctive characteristics. Similar differences have been observed in nitro-toluol; M. Jaworsky obtained this product in the crystallised state; and M. Alexeyeff demonstrated that reduction transformed it into toluidine, totally and immediately crystalline. M. Kekulé concludes from these facts that the liquid nitro-toluol hitherto known must be impure.

About three years ago M. Coupiér introduced to commerce a toluidine but partially crystallisable, and containing only 20 per cent of aniline. To this liquid toluidine appertains the valuable quality of forming, with arsenical acid, a red colouring matter analogous to fuchsine. This property has hitherto been attributed to an admixture of aniline and toluidine; and the liquid form of M. Coupiér's product was supposed to be due to the presence of a certain quantity of aniline.

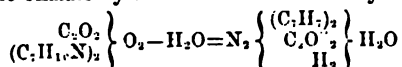
Several facts are opposed to this view of the question. There is the constant boiling point of the alkaloid (198°), then its elementary composition, which answers to the formula of toluidine; and, lastly, the circumstance that the yield of pure red dye is vastly superior to that obtained from admixtures of pure aniline and crystallised toluidine in the most favourable proportions.—(*Bulletin de la Société Industrielle de Mulhouse*, p. 264, 1866.)

When liquid toluidine is cooled to below zero, and a drop of water thrown in, part of the mass solidifies, and the crystallised toluidine separates. The liquid which remains still possesses the boiling point and the composition of toluidine; but when treated with arsenic acid the yield of red is less—15 per cent. in lieu of 45 per cent.

This liquid is the best primary substance for the preparation of the new alkaloid. It is to be transformed into oxalate, which is exhausted by ether free from alcohol; the undissolved portion consists of pure oxalate of toluidine; the part dissolved consists of an oxalate, crystallisable from ether, alcohol, and water. When decomposed by soda, this oxalate furnishes a liquid alkaloid. To ascertain that this was indeed a simple alkaloid, it was transformed into a chloride and separated by successive crystallisations into four deposits; each of these deposits was recrystallised, and

its solubility in water determined. The constancy of this solubility was looked upon as a proof of complete purity. By the aid of this salt the free alkaloid employed in the following experiments was prepared.

Recently rectified over fused potash, this base is colourless, but colours gradually in the air. It remains liquid at -20° , its odour resembles that of toluidine, its density is 1.0002, and it boils at 198° at a pressure of 7.44 millimetres. Analysis led to the formula C_9H_9N . This formula was controlled by the analysis of its oxamide, which crystallises in beautiful silky looking needles, easily obtained quite pure. This amide differs from the oxalate by a molecule of water only:—



The alkaloid regenerated from this amide was also analysed, and the results accord with the preceding analyses. As it is, therefore, an isomer of toluidine, I will call it pseudo-toluidine, that being the only name I feel justified in giving it, while still ignorant of its exact constitution. It is sufficiently plentiful—the liquid toluidine of M. Couper contains about 36 per cent, commercial aniline often more than 20 per cent.

Pseudotoluidine does not seem to be identical, either with methylaniline, which boils at 192° (Hofmann, 1850, *Annalen der Chemie und Pharmacie*, lxxiv., p. 150); or with the alkaloid described by Limpricht, under the name of benzylamine (*loc. cit.*, cxiv., p. 304), which boils at 183° .

I have carefully compared the crystalline form, and the solubility of the chlorhydrate and oxalate, with those of the corresponding salts of aniline and toluidine. The establishment of this difference is very important.

The form of the chlorhydrate is undeterminable; the salt of pseudotoluidine forms an orthorhombic prism; that formed by the toluidine is clinorhombic. Their solubility in the same order are respectively, in a hundred parts of water, 129 at 17° ; 7; 37; 5 at 15° ; 5; 22; 9 at 11° .

The coloured reactions of this solution are alike different to those of aniline and toluidine; but I shall return to this part of the subject in another communication.

When heated with arsenic acid, pseudotoluidine does not produce red, but if combined with pure crystallised toluidine, it yields an abundant red colouring matter, containing at least 50 per cent of a rosaniline salt; during the reaction much aniline also distils. An explanation of this remarkable fact would require a profound study of the composition of the new alkaloid.

Here is another circumstance not less striking. When mixed with aniline and treated by arsenic acid, pseudotoluidine produces plenty of red colouring matter, similar to fuchsine, but differing from salts of rosaniline in the solubility of its base in ether, and the still greater solubility of its chloride in water. It appears from its origin to be an isomer of rosaniline.

The anilines now employed in the manufacture of fuchsines contain much less aniline than formerly, but I have proved that they contain as much more pseudotoluidine. At the same time the composition of the reds is changed; the red which I have described must now be recognised, in addition to the chloride of rosaniline, whose formula Hofmann has so clearly established.

Salts of pseudotoluidine, mixed with chlorate of copper and applied on cotton, give a fine black; this black approaches violet, whilst pure aniline under the

same conditions produces a blue black. I ought to observe, in concluding this summary, that the purity of the alkaloids used by me in the course of these experiments was verified by the laborious but sure process employed upon the pseudotoluidine.—(*Comptes Rendus*, lxxvii., 45.)

ON THE PROXIMATE ANALYSIS OF COALS.

BY PROFESSOR GUSTAVUS HINRICHS,

CHEMIST OF THE GEOLOGICAL SURVEY OF IOWA.*

COAL is not a simple chemical combination, expressible by a chemical formula; but it is the final residuum of vegetable matter having been exposed to a long-continued and complex process of addition and subtraction. An elementary analysis will therefore not teach us much in regard to the nature of the combustible; for who would dare to make any conclusion concerning the peculiar combination of the elements thus determined? Even the heating effect calculated from this elementary analysis is not more trustworthy than the valuation by the reduction of lead.

The proximate analysis, on the contrary, enables us to learn something in regard to the real nature of the fuel. The moisture and the ashes are both not only diluents of the fuel, but in themselves obstacles to the effectiveness of the same; the vaporisation of the moisture causes a serious loss of heat, while the ashes, by hindering a complete combustion, and by the heat they contain when dropped through the grate, constitute another loss. By furthermore determining the total amount of volatile matter, we learn both the percentage of coke in the fuel, and the amount of carbon (fixed combustible) and bitumen (volatile combustible matter). Although neither of these two products can be considered as simple chemical compounds, it is nevertheless of the utmost practical importance to know these two quantities, because of the great importance of coke and gas in the arts. The yield in gas of a fuel is no doubt measured by the percentage of bitumen, at least for coals from the same basin—coals which therefore may be supposed to have passed through nearly the same chemical history.

In taking charge of the chemical labours of the Geological Survey of Iowa, I had grave doubts in regard to the value of this proximate analysis of coals. No investigation as to its accuracy, nor as to the best method of conducting the work, had come to my knowledge. The European chemists seem almost exclusively to rely on the elementary analysis, while in the great Government surveys of this country the proximate analysis seems to have been almost as exclusively practised. But while the former may readily be turned into approximate determinations of the heating effects of the fuel, the latter have, to my knowledge, never been used for such purposes, nor was it at all apparent that they ever could be thus made useful.

In regard to the first condition of all quantitative determinations, that of giving constant results for the same substance, but few observations were accessible, and these rather increased my first distrust. Thus Whitney, nowhere in his report on the coals of Iowa (*Geology of Iowa*, vol. i., part 1), gives any data whatever in regard to this most important question, although he devotes a very large space to the subject.

* From the American Journal of Mining, published in advance of the official report.

Only the final results are given; but whether the individual determinations deviated much or little from the same, cannot be ascertained; or, in other words, the degree of accuracy or reliability of his reported results is altogether unknown. The report of Dr. Jas. V. F. Blaney on the coals of Illinois (Geology of Illinois, vol. i., 1866, p. 258-277), insists on the great correspondence of the amount of bitumen volatilised to varying circumstances, but only in general terms, no experimental data being brought forward. Fortunately, this chemist gives for four samples of coal the direct result of two determinations; but the differences between these two determinations on the same sample are respectively

3.04 1.50 1.32 0.07

per cent, the mean of which is 1.48, or very nearly one and a half per cent. This result certainly was not calculated to incline me favourably to the proximate analysis of coals.

On the other hand, the usual applications of coal demand such analysis, and my reduction of the analysis of Whitney and Blaney (mentioned in No. 22 of the *American Journal of Mining*) proves, by the results obtained, that the determinations must be more reliable than the above figures would indicate.

It thus became necessary for me, before making any proximate analysis of the many samples of Iowa coals put into my hands by the State Geologist, Dr. C. A. White, to make a rather extensive and thorough search into the method itself, in order to study its exact value. Since I, in these determinations, according to the varied circumstances, for the same sample of coal, obtained values ranging from 41.77 to 57.31 per cent, for the amount of volatile matter, it seems not only that such investigation was sufficiently called for, but even that it shows the proximate analysis to be worthless; a variation of 15.54, or rather 16 per cent for the same sample, seems to condemn the method admitting of such results.

In the determination of magnesia, as large variations could be obtained by exposing the crystallised double phosphate to various conditions; and yet this determination, properly executed, is one of the most accurate known in analysis.

It is easily seen that the following elements will modify the result of the amount of volatile matter driven off from a sample of coal contained in a covered platinum crucible:—weight of coal and of crucible, degree and duration of heat, condition of coal. I hope to show that this determination, notwithstanding all these elements, admits of an accuracy of one-tenth of a per cent, equal to that of weighing a gramme exact to the milligramme.

The sample of coal used for this purpose was not selected, but taken at random; it was labelled No. 350, and is from the bottom of Roberts and Fisher's Bank, which bank is 5 to 6 feet thick, 7 miles west of the town of Pella, in Marion County, Iowa. From this sample a very pure piece, free from any visible admixture of either gypsum or pyrites, was selected. By means of 2.760 coal, in coarse fragments of about 1-10 cubic centimetre and a 50 gramme flask, the specific gravity of this coal was found to be 1.328.

Determination of the Volatile Matter.

Source of Heat.—A common Bunsen burner was used (red heat), and also a gas burner with six jets, surmounted by a French soufflet cylindrique (white heat),

care being taken to keep the gas-cock in the same position by means of an arm of 10 inches in length. These two sources of heat we will denote respectively "BB," and "Blast."

The time was usually measured by means of a small sand-glass, running exactly three and a half minutes; this duration we will denote by *t*. Thus BB, *t* means that the crucible was exposed to the constant flame of the Bunsen burner during three and a half minutes.

Influence of Quantity of Coal.

1. Coal pulverised, not dried; heat, BB, *t*; cooled and weighed; then blast, *t*; then weighed again.*

N. of Exper.	Weight.	Volatile, pr. ct.	Deviation.	Crucible.
d	5.360	48.24	-1.14	19.2
n	1.910	49.58	+0.20	19.2
e	1.147	49.87	+0.49	11.6
o	1.031	49.85	+0.47	9.4

Mean 49.38

2. Coal in small fragments; heat as in 1.

h	3.743	48.30	-0.94	19.2
g	1.130	50.18	+0.94	9.4

Mean 49.24

For the same heat, the amount volatilised is the greater the smaller the mass heated; whether the coal is in small fragments or pulverised hardly makes any difference; but since the bitumen passed off more regularly when the coal was pulverised, while, when in fragments, slight explosions sometimes occurred, the coal should be pulverised, for the determination of the bitumen.

3. Coal, pulverised, between 1 and 2 grammes; heat, as above.

N. of Exper.	Weight.	Volatile, pr. ct.	Deviation.	Crucible.
n	1.910	49.58	-0.19	19.2
e	1.147	49.87	+0.10	11.6
o	1.031	49.85	+0.08	9.4

Mean 49.77

giving, as probable error of a single determination, only 0.108 per cent, or only 1 milligramme for 1 gramme of coal. This is not greater than that of the weighing itself, in which fractions of a milligramme were usually neglected.

4. Coal, pulverised (new portion), and between 1—2 grammes; heat, BB, *t*; immediately thereafter blast, *t*, without cooling.

N. of Exper.	Weight.	Volatile, pr. ct.	Deviation.	Crucible.
a'	1.160	50.86	+0.14	9.4
n'	1.040	50.58	-0.14	11.0

Mean 50.72

Another determination was made (*o'*), but on account of side-draft while over BB, the crucible cooled several times; correspondingly the result deviated much, being only 49.10.

From 3 and 4 we conclude, that if the substance taken is from 1 to 2 grammes, the result will be constant for the same mode of heating.

* Weight=coal taken in grammes; crucible=weight of the same. Deviation per cent from the mean given. These quantities are given in the same order in all subsequent tables, unless stated otherwise.

Influence of Drying the Coal before Ignition.

5. Coal, fragments; heat B B, *t*; not cooled; blast, *t*, with the probable error of one single determination, 0.45.

N. of Exper.	Weight.	Volatile, pr. ct.	Deviation.
<i>t</i>	1.361	48.49	+0.76
<i>u</i>	1.050	47.26	-0.47
<i>v</i>	1.030	47.43	-0.30

Mean 47.73

Comparing this with 4 (same heating), it appears that about 3 per cent less volatilised by previous drying, and also that the accuracy of one determination is four times less than when the coal is ignited without previous drying. In the arts, the coal is not artificially dried before coking. For all of these reasons, the amount of volatile matter is best determined on undried coal.

6. In general, I found, as means,

4 dried coals gave	47.97 per cent volatile
10 undried " "	49.87 " "

confirming the above.

Influence of Cooling after the Ignition over the Bunsen Burner, and before the Ignition over the Blast-Flame.

7. Coal, pulverised, not dried; heat, B B, *t*; then blast, *t*, without cooling.

N. of Exper.	Weight.	Volatile, pr. ct.	Deviation.
<i>x</i>	1.314	49.01	-0.02
<i>y</i>	1.156	49.05	+0.02

Mean 49.03

which, compared with the corresponding case, 3, giving the mean 49.77, and maximum deviation 0.19, shows that by the intermediate cooling about $\frac{1}{2}$ per cent more is volatilised. This probably is due to the fact that the crucible upon cooling is filled with atmospheric air, which, upon renewed ignition, must burn a corresponding amount of coal.

Influence of Repeated Heating, the Crucible being after each Ignition Cooled and Weighed.

8. Coal = *r* = 1.628 in crucible 19.2 was dried, then ignited (B B, *t*), and lost 41.77 per cent. Being ignited again in the same way, it lost 2.76, per cent, or in all, 44.53. Being successively ignited seven times, B B, each time for six minutes, the total loss was 52.39, or, on the average for each of these six minute B B ignitions, 1.12 (two of the determinations nearest this average were 1.06 per cent).

Hereafter the same was five times for three and a half minutes exposed to the blast; the volatile passed off amounted to 57.31, giving for each of these last ignitions the average loss of 0.98 per cent.

It now had been ignited fourteen times, each time having been cooled and weighed; and we have fourteen ignitions, 57.31 volatile—first ignition, 41.77 volatile; hence, average for each of the thirteen ignitions, 1.195, or 1.2 per cent.

This series of experiments shows that it is impossible to heat coal until no further loss is sustained; for it is apparent that each heating, after complete cooling, produces, on the average, more than the additional volatilisation of 1. On 1 gramme coal taken, 1 per cent carbon burnt requires about 30 milligrammes, or 20 cubic centimetres of oxygen. We may, therefore, consider these excesses almost equal losses due to a real combustion.

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Influence of Protracted Heating.

9. Coal, pulverised, not dried; heat, always first B B, *t*; and then immediately, without cooling, transferred to blast-lamp.

No.	Weight.	Blast.	Volatile.	Difference.	Difference per minute.
<i>a' + n'</i> (mean)	3 min.		50.72	0.57	0.19
<i>c'</i>	6 "		51.29	1.04	0.35
<i>d'</i>	9 "		52.33	1.95	0.65
<i>d'</i>	12 "		54.28	2.93	0.16
<i>k'</i>	30 "		57.21		

By comparing each with the first mean, we obtain for each minute blast after the first three, respectively,

0.24 0.39 0.27 0.20

showing less difference than the above.

The volatilisation, after the three first minutes blast, is therefore increasing $\frac{1}{2}$ to 2.5 per cent for six minutes, and then very slowly decreasing to about 1.5 per cent for half an hour. At this rate the loss is twelve per hour.

It is apparent that the loss is less than when cooled in the intervals, but it proves that a slight current of air must get at the coal in the covered crucible.

At any rate it is demonstrated, that the rule which is sometimes given, to heat until no further loss is sustained, demands an impossibility.

Influence of the Degree of Heat.

10. Coal, pulverised, not dried; heat, B B, *t*; cooled and weighed; then blast, *t*; cooled and weighed again.

After B B.

N. of Exper.	Weight.	Volatile, pr. ct.	Deviation
<i>n</i>	1.910	48.03	+0.42
<i>e</i>	1.147	47.69	+0.03
<i>o</i>	1.031	47.23	-0.43

Mean 47.66

Prob. error 0.284

After Blast.

N. of Exper.	Volatile pr. ct.	Deviation.
<i>n</i>	49.58	-0.13
<i>e</i>	49.87	+0.11
<i>o</i>	49.85	+0.09

Mean .. 49.76

Prob. error 0.108

showing that the higher temperature gives the most accurate results.

Result.

From this investigation we conclude—

The total volatile matter of coal is determined with accuracy (1 mgr. on 1 gr. coal), by taking 1 to 2 grammes of undried, pulverised coal, heating it for three and a half minutes over a Bunsen burner (bright red heat), and then immediately, without cooling, for the same length of time, over a blast gas-lamp (white heat).

ON THE

OCCCLUSION OF HYDROGEN GAS BY METALS.*

BY THOMAS GRAHAM, F.R.S.,

MASTER OF THE MINT.

In my experiments, already published, on the occlusion of hydrogen by the metals palladium, platinum, and iron, the absorption of the gas was observed to be of uncertain occurrence at low temperatures, but was

* From the *Proceedings of the Royal Society*, No 102, 1868, with additions and corrections by the author.

ensured by heating the metal, whether in the form of sponge or aggregated by hammering, and allowing it to cool slowly and completely in a hydrogen atmosphere. This fact was referred to the condition of absolute purity of the metallic surface being essential to the first absorbing action, as it is to the action of platinum foil or wire in determining the combustion of the gaseous mixture of oxygen and hydrogen, as observed by Faraday. A new method of charging the metals with hydrogen at low temperatures has lately presented itself, which is not without interest.

When a plate of zinc is placed in dilute sulphuric acid, hydrogen is freely evolved from the surface of the metal, but no hydrogen is occluded and retained at the same time. A negative result was indeed to be expected from the crystalline structure of zinc. But a thin plate of palladium immersed in the same acid, and brought into metallic contact with the zinc, soon becomes largely charged with the hydrogen, which is then transferred to its surface. The charge taken up in an hour by a palladium plate, rather thick, at 12° amounted to 173 times its volume.

The absorption of hydrogen was still more obvious when the palladium plate was constituted the negative electrode in acidulated water to a Bunsen battery of six cells. The evolution of oxygen gas at the positive electrode continuing copious, the effervescence at the negative electrode was entirely suspended for the first twenty seconds, in consequence of the hydrogen being occluded by the palladium. The final absorption amounted to 200.4 volumes, and was greater in amount than the volume of hydrogen occluded by the same plate heated and cooled in an atmosphere of the gas, which did not exceed 90 volumes.

It is worthy of remark that, although the hydrogen enters the palladium and no doubt pervades the whole mass of the metal in such circumstances, the gas exhibits no disposition to leave the metal and escape into a vacuum, at the temperature of its absorption. Thus a thin plate of palladium, charged with hydrogen in the manner described, was washed, dried by a cloth, and then sealed up in an exhausted glass tube. On breaking the tube under mercury after two months, the vacuum was found perfect. No hydrogen had vaporised in the cold (about 12°); but on the application afterwards of a heat of 100° and upwards, 333 volumes of gas were evolved from the metal.

A similar result was obtained on making a hollow palladium cylinder, of which the length was 115 millimetres, diameter 12 millimetres, and thickness 1 millimetre, the negative electrode in an acid fluid, while the closed cavity of the cylinder was kept exhausted by means of a Sprengel aspirator. No hydrogen whatever passed through into the vacuous cavity in several hours, although the gas was no doubt abundantly absorbed by the outer surface of the cylinder and pervaded the metal throughout.

It appears, then, that when hydrogen is absorbed by palladium the volatility of the gas may be entirely suppressed; and hydrogen may be largely present in metals without exhibiting any sensible tension at low temperatures. Occluded hydrogen is certainly no longer a gas, whatever may be thought of its physical condition. The same conclusion was indicated by another series of experiments, in which it was found that, to be occluded by palladium, and even by iron, hydrogen does not require to be applied under much pressure, but, on the contrary, when highly rarefied is still freely absorbed by these metals.

The occluded hydrogen is readily extracted from palladium by reversing the position of the latter in the decomposing cell of the battery, so as to cause oxygen to be evolved on the surface of the metal. The hydrogen is then drawn out as rapidly as it had previously entered the palladium, and the metal is exhausted in a complete manner by such treatment. When palladium charged with hydrogen is left exposed to the atmosphere, the metal is apt to become suddenly hot, and to lose its gas entirely by spontaneous oxidation.

Platinum may be charged with hydrogen by voltaic action, as well as palladium, but with the usual inferior proportion of gas. The charge of hydrogen taken up in a decomposing voltaic cell by old platinum in the form of a tube, of the thickness of a small crucible, was 2.19 volumes. This absorbed gas was also readily withdrawn from the platinum and oxidised on reversing the place of the metal in the decomposing cell. The platinum acquired its well-known polarising-power in virtue of the occluded hydrogen. This power was retained by the metal after being washed with pure water and wiped with a cloth, and was brought into action on placing the metal in dilute acid. The temperature required to expel the hydrogen so absorbed by platinum was found to be little short of a red heat, although the gas had entered the metal at a low temperature.

Soft iron, left some time in a dilute acid, occluded 0.57 volume of hydrogen. This charge of gas was also retained at low temperatures, and did not escape into a vacuum till the temperature was raised nearly to redness. This proves that, like platinum, iron is not penetrated through in the cold by hydrogen, the temperature of emission being elevated considerably.*

While hydrogen was absorbed freely by palladium and platinum as negative plates, no oxygen whatever was absorbed by plates of the same metals in the position of positive electrodes. Oxygen gas was disengaged freely on the surface of the latter without being condensed. A platinum plate which had acted for several hours as a positive electrode, gave afterwards, when submitted to heat with exhaustion, a small trace of carbonic acid but no oxygen.

The familiar igniting-power of platinum sponge (or clean plate) upon a jet of hydrogen in the air seems to depend solely upon the influence of the metal upon its occluded hydrogen. The hydrogen appears to be polarised, and to have its attraction for oxygen greatly heightened. I beg to offer the following representation of this phenomenon, with an apology for the purely speculative character of the explanation. The gaseous molecule of hydrogen being assumed to be an association of two atoms, a hydride of hydrogen, it would follow that it is the attraction of platinum for the negative or "chlorulous" atom of the hydrogen molecule which attaches the latter to the metal. The tendency, imperfectly satisfied, is to the formation of a hydride of platinum. The hydrogen molecule is accordingly polarised, *orientes*, with its positive or "basulous" side turned outwards, and having its affinity for oxygen greatly enlivened. It is true that the two atoms of a molecule of hydrogen are considered to be inseparable; but this may not be inconsistent with the replacement

* In M. Callot's experiment of exposing a thin sheet of iron to an acid, the metal is no doubt penetrated through by hydrogen in the cold, but apparently from the penetrating agency of the acid which is insinuating itself into the metal at the same time.—*Comptes Rendus*, May 4, 1868.

of such hydrogen atoms as are withdrawn, on combining with oxygen, by other hydrogen atoms from the adjoining molecules. It is only necessary to suppose that a pair of contiguous hydrogen molecules act together upon a single molecule of the external oxygen. They would form water, and still leave a pair of atoms, or a single molecule of hydrogen, attached to the platinum.

The oxidation of alcohol, ether, and similar hydrocarbons, through the agency of platinum, likewise appears to be always an immediate consequence of a similar polarisation of the hydrogen of those substances, or of some other oxidisable constituent.

As has already been remarked, it does not follow that, because a gas is occluded by a metal, under the pressure of the atmosphere, at a low temperature, the gas will also escape from the metal into a vacuum at the same temperature, a much higher temperature being often required for the expulsion of the gas than for its first absorption. This is particularly true of carbonic oxide occluded by iron. Cast iron is much too porous for such experiments, and allows carbonic oxide, equally with other gases, to pass through abundantly by the agency of gaseous diffusion. Even with malleable iron there is a difficulty in observing, owing to the long time during which that metal continues to discharge carbonic oxide from its own store of that gas. But a malleable iron tube, first thoroughly deprived of its natural gas, was found to allow carbonic oxide to pass through it into a vacuum very slowly compared with hydrogen, although the volume of carbonic oxide which the metal is capable of absorbing is very sensible, amounting to four volumes, and more considerable than the volume of hydrogen which the same metal can occlude. Carbonic oxide did not sensibly pass through iron of 1·7 millimetre in thickness till the temperature was greatly elevated; and then the passage of gas was, in a minute—

Of carbonic oxide, at a full red heat, 0·284 cubic centimetres per square metre of surface.

Of hydrogen, at a full red heat, 76·5 cubic centimetres per square metre of surface.

The condition of hydrogen as occluded by a colloidal metal may be studied with most advantage in its union with palladium, where the proportion of gas held is considerable. In the pulverulent spongy state, palladium took up 655 volumes of hydrogen; and so charged it gave off no gas *in vacuo* at the ordinary temperature, nor till its temperature was raised to nearly 100°. Hammered palladium foil has been observed to take up quite as much gas. But the condition in which palladium appears to be most absorptive is when precipitated from a solution of about 1·6 per cent of the chloride, by the action of a voltaic battery, in the form of a compact metal. Palladium is not one of the metals readily thus precipitated; but it may be thrown down upon a thin platinum wire, in brilliant laminae, by the action of a large single cell. The palladium after a time detaches itself from the wire, exhibiting a bright white metallic surface where it had been in contact with the platinum, and a dull surface suggesting metallic arsenic, on the side exposed to the acid. As so prepared, it does not contain any occluded hydrogen. But the metallic films, when heated to 100° in hydrogen, and allowed to cool slowly for an hour in the same gas, were found to occlude 982·14 volumes of gas, measured with the thermometer at 11°, and barometer at 756 millimetres. This is the largest absorption of hydrogen observed. From palladium so charged

there was a slight indication of the escape of hydrogen into a vacuum, with extreme slowness in the cold. This charged palladium is represented by weight as—

Palladium 1·0020 grm. 99·277
Hydrogen 0·0073 grm. 723

100·000

It is in the proportion of one equivalent of palladium to 0·772 equivalent of hydrogen,* or there is an approximation to single equivalents Pd II. But the idea of definite chemical combination is opposed by various considerations. No visible change is occasioned to the metallic palladium by its association with the hydrogen. Hydrides of certain metals are known, as the hydride of copper (Wurtz) and the hydride of iron (Wanklyn); but they are brown pulverulent substances with no metallic characters. Indeed a hydride of palladium itself can be formed, but not preserved, on account of its great instability. Following the process of M. Wurtz for the hydride of copper, nitrate of palladium was boiled with sulphuric acid, and the sulphate of palladium (a red crystalline salt) prepared. A solution of this salt, with an excess of sulphuric acid, was precipitated by the hypophosphite of soda; a black powder fell, which speedily underwent decomposition at 0°, evolving copious volumes of hydrogen gas. The final residue appeared to be pure palladium, of its usual black amorphous appearance, and with no trace of crystallisation. It is singular that this palladium precipitate contained no occluded hydrogen; and even when dried, and afterwards exposed to an atmosphere of hydrogen in the usual manner, the palladium black so prepared condensed no sensible quantity of that gas. It acquired this property, however, after being heated to redness and converted into grey palladium.

I am inclined to conclude that the passage of hydrogen through a plate of metal is always preceded by the condensation or occlusion of the gas. But it must be admitted that the rapidity of penetration is not in proportion to the volume of gas occluded; otherwise palladium would be much more permeable at a low than at a high temperature. A plate of that metal was sensibly exhausted of hydrogen gas at 267°, but continued permeable, and in fact increased greatly in permeability at still higher temperatures, and without becoming permeable to other gases at the same time. In a striking experiment, a mixture of equal volumes of hydrogen and carbonic acid was carried through a small palladium tube, of which the internal diameter was 3 millimetres, and the thickness of the wall 0·3 millimetre. From the outer surface of this tube gas escaped into a vacuum, at a red heat, with the enormous velocity of 1017·54 cubic centimetres per minute for a square metre of surface. This gas did not disturb baryta-water. It was pure hydrogen.

A still more rapid passage of hydrogen was observed through the substance of a hollow cylinder of palladium 1 millimetre in thickness, at a higher temperature, approaching the melting-point of gold. The palladium cylinder being enclosed in a porcelain tube charged with pure hydrogen, was exhausted as usual, and gave 105·8 cubic centimetres of gas in five minutes; measured with barometer 753 millims., thermometer 10°. As the external surface of the palladium tube amounted to 0·0053 square metre, the passage of gas was—

3992·22 cubic centimetres (4 litres nearly) from a square metre of surface, per minute.

(* II—1, Pd 106·3.

The rate of penetration of hydrogen through the same palladium tube, at the lower temperature of 265° C., was previously observed to be—

327 cubic centimetres from a square metre of surface per minute.

The velocity of penetration thus appears to increase in a rapid ratio with the temperature.

When carbonic acid was substituted for hydrogen, at the same high temperature, a very minute penetration was perceived, amounting to—

1·86 cubic centimetres from a square metre of surface, per minute.

This gives for carbonic acid one twenty-thousandth part of the rate of hydrogen. Whether it is a penetration of the same sort, although greatly less in degree, or rather the consequence of a sensible porosity in the palladium (of which it would become the measure), remains uncertain.

The quantity of hydrogen held by the metal at these high temperatures may become too small to be appreciated; but I presume it is still present, and travels through the metal by a kind of rapid cementation. This extreme mobility is a singular property of hydrogen, which was involved in the fundamental discovery, by MM. H. Sainte-Claire Deville and Troost, of the passage of that gas through plates of iron and platinum at high temperatures.

The marked rapidity of the passage of the same gas through a thin sheet of caoutchouc appears to be more capable of explanation on known principles. Caoutchouc of less than 0·1 millimetre in thickness, if impregnated with hydrogen, loses its gas entirely by the most momentary exposure to the air. A tube of two millimetres in thickness, through which hydrogen and carbonic acid were singly passed, each for an hour, was found to retain—

Of hydrogen.....0·0113 volume.
Of carbonic acid.....0·2200 "

The absorption, then, is in the proportion of one hydrogen to twenty carbonic acid; but the comparative rate of penetration of the two gases through a sheet of caoutchouc is as one hydrogen to two and a half carbonic acid; or the hydrogen moves eight times as rapidly as the density of its solution would indicate. But these gases differ in diffusibility as carbonic acid 1 to hydrogen 4·7. The rapid passage of hydrogen through caoutchouc is thus partly explained by the rapid manner in which that gas is brought to one surface of the sheet and conveyed away from the other by gaseous diffusion. Again, both substances travel through the substance of the caoutchouc by their diffusibility as liquids. Suppose hydrogen in that form to be nearly as much more diffusive than the other substance as it is when both are gaseous, then the observed rapid passage of hydrogen through caoutchouc would appear to be fully accounted for.

Liquid diffusion has also a bearing upon the rapid dissemination of hydrogen through a soft colloid metal, like palladium or platinum, at a high temperature. The liquid diffusion of salts in water is known to be six times as rapid at 100° as at 0°. If the diffusion of liquid hydrogen increases with temperature in an equal ratio, it must become a very rapid movement at a red heat. Although the quantity absorbed may be reduced (or the channel narrowed), the flow of liquid may thus be increased in velocity. The whole phenomena appear to be consistent with the solution of

liquid hydrogen in the colloid metal. The "solution affinity" of metals appears to be nearly confined to hydrogen and carbonic oxide, so that metals are not sensibly penetrated by other gases than these.

FOREIGN SCIENCE.

PARIS, JULY 1ST, 1868.

Method of analysing commercial acetate of lime.—Estimation of iodine in the residues of the aniline colour factories.—Constitution of iodide of starch.—New process for the manufacture of white lead.—Preservation of ferments.—Employment of phosphide of zinc in therapeutics.

M. FRESENIUS has proposed a new method of effecting analyses of commercial acetate of lime. The ordinary process consists in estimating the acetic acid by difference, after calcining the acetate; since the commercial product always contains tar and other impurities, the process is inaccurate. The method adopted by M. Fresenius is the following: 5 grammes of the acetate to be examined are introduced into a retort with 50 c.c. of water and 50 c.c. of phosphoric acid of 1·2 density, and free from nitric acid. The mixture is distilled with care to dryness, 50 c.c. of water are then added and the distillation repeated. The operation having been made a third time, the distillates are united, and diluted to 250 c.c.; 50 c.c. are then taken for a titration with standard soda solution. It is not necessary to search for hydrochloric acid in the distillate, for the amount of this acid can be ascertained after the titration by means of standard nitrate of silver.

The same eminent chemist has also made known a method of estimating iodine in the residues from the manufacture of aniline colours. There are now found in commerce mother liquors worked for the manufacture of iodine, and containing besides this metalloid, sensible quantities of alkaline arseniates and arsenites, as well as organic matter. These waters occur in the manufacture of aniline colours; their value depends upon the amount of iodine they contain, the amount of this metalloid and the proportion engaged in the organic matter are therefore the two things that are required. The following is the process: 10 grammes of liquid are treated with 2 grammes of potash in concentrated solution, the mixture is then evaporated to dryness in a chimney with a good draft, or in the open air, on account of the cacodylic products occasioned, and ignited ultimately. The aqueous solution of the residue is made up to 250 c.c., of which 20 c.c. are treated by a mixture of sulphuric and hyponitric acids. The iodine from the 20 c.c. is separated by agitating with sulphide of carbon; as the sulphide of carbon solution may be acid, it is necessary to agitate with water until the washings no longer affect litmus paper; when this is attained, a titration is made with hyposulphite of soda.

Iodide of starch as been subjected to an examination by M. Guichard. Since its discovery, the constitution of this body has been often discussed; according to some chemists it is only a mixture of iodine and starch, or starch tinted by iodine; others on the contrary consider iodide of starch to be a definite combination of iodine and starch, with excess of iodine. The general opinion is that the iodide of starch is a simple mixture, and the colourless iodide is only starch with hydriodic acid. M. Guichard thought that an examination with the dialyser would throw light upon the question. If there existed, in fact, a combination of iodine and starch, the compound ought to be colloidal, and remain in the dialyser; if, on the contrary, only dissolved iodine and hydriodic acid were there, starch would alone remain. M. Guichard made a great number of experiments; he remarked that iodine passed the dialyser first, then hydriodic acid in large quantity, afterwards the iodide became suddenly decolourised, and later the iodine, as well as the hydriodic acid, ceased to be disengaged. When the experiment was made with iodide of starch decolourised by heat, the disengagement of iodine was difficult to perceive, that of hydriodic acid was alone observed; the same

was the case with the iodide heated in close vessels for some hours to 100° , then to 150° . The colourless iodide of starch has then no existence; the so-called iodide of starch is simply starch tinted by iodine. Heat thus separates the iodine from the starch; the iodine then remains in the water, either as such or as hydriodic acid.

M. A. Girard has recently invented a new process for the manufacture of white lead. The lead is first prepared for treatment by granulating it; the granulated metal is placed in a rotating cask (which should be made of beech or elm, not oak) with one-fourth its weight of pure water. The cask is made to rotate at the rate of thirty or forty turns a minute, and arrangements are made for the passage of a current of air during the rotation. After about two hours, nearly the whole of the lead is found to be oxidised, and then carbonic acid is introduced in the place of the current of air, and the rotation continued for four or five hours further. At the end of this time nearly the whole of the lead is found to be converted into hydrated carbonate, fine white lead, which can be separated from all the metal remaining intact by decantation.

At a meeting of the *Société de Pharmacie*, M. Mialhe gave an account of his researches on the preservation of ferments. The conclusion to be drawn from these researches is, that physiological ferments can retain indefinitely their action when suitably dried. This fact confirms the assertion of Roucloux relative to the activity of dry vaccine lymph, and Maugili's relative to the dried poison of the snake.

M. Vigier read at the same meeting a communication on the therapeutic employment of phosphide of zinc by M. Curie and himself. The phosphuretted preparations in use, he said, offer such great inconveniences as to create a serious obstacle to the employment of phosphorus in therapeutics; they are either repugnant to the taste, or uncertain. Phosphide of zinc, on the contrary, unites the conditions of an excellent medicament, and seems destined to replace all the other preparations of phosphorus; it is a grey crystalline substance, perfectly definite, unalterable in moist air, and still decomposed by the juices of the stomach. This phosphide produces in animals poisoned by it the same effects as phosphorus—alteration of the blood, congestion of the lungs, paralysis of the heart, alteration in the cells of the liver, &c.

PARIS, JULY 8TH, 1868.

Researches on indium.—A new isomer of amyllic alcohol.—The carbylamines.—A new alcohol, isomeric with caprylic alcohol.

UNDER the title of "Researches on indium," a valuable contribution has been added to the chemical history of this element. MM. Reich and Richter, in isolating the element, dissolved the oxidised blende or the zinc in hydrochloric acid, and submitted the chloride to distillation; this chloride they digested with a quantity of water insufficient to dissolve the whole; the acid residue was dissolved in water, the solution mixed with nitric acid, and supersaturated with ammonia. The precipitate, thus obtained, redissolved in acetic acid yields crude sulphide of indium. M. Winkler's paper refers (1) to the occurrence in nature of indium, (2) to the extraction of the metal, (3) to its properties, (4) to the equivalent, and (5) to its combinations. No mineral is at present known which contains a notable quantity of indium; the only blendes in which the element has been as yet observed are the Freiberg blende and the Brecht blende of Breitenbrunn, or *christophite*, which contains 0.0062 per cent of indium. The extraction of indium from the blende is a tedious operation. The powdered mineral is submitted to a thorough roasting at dull redness; the roasted product contains much sulphate of zinc, nearly all the indium in the state of sulphate, but very few other soluble metallic salts. By dissolving out the soluble matters a clear liquid, slightly ferruginous, is obtained, from which metallic zinc separates the indium, as well as copper, cadmium, &c. Only traces of indium are contained in the residue after washing. The process just described is the most advantageous one when

operations are made on a large scale, but in other circumstances, to work upon the Freiberg zinc is more convenient. The metallic zinc is treated by dilute sulphuric acid, in insufficient quantity to dissolve the whole. After several weeks' contact, or by ebullition with excess of zinc, there is formed a spongy metallic residue, which amounts usually to 2 per cent of the weight of zinc employed, and which contains lead, copper, cadmium, arsenic, and indium; the indium constitutes about 2 to 2.5 per cent of this deposit. Thus 10 kilogrammes of zinc gave M. Winkler 208 grammes of metallic residue, containing 4.312 grammes of indium. To extract the indium from this deposit, concentrated sulphuric acid is added, and a sufficient heat applied to expel the excess of acid; the result is a grey pulverulent mass, which, after calcination in a crucible, becomes quite white. By digestion in water the sulphates are dissolved, with the exception of sulphate of lead. By precipitating the filtered liquor with ammonia, the impure hydrate of indium is obtained; this precipitate is redissolved in the smallest possible quantity of hydrochloric acid, sulphurous acid added to reduce the iron to the minimum state of oxidation, and the solution digested with carbonate of baryta, which precipitates the whole of the indium after sufficiently long contact. MM. Reich and Richter originally fixed the equivalent of indium at 37.2, while M. Winkler found the figure 35.8. New determinations have led him to adopt the number 37.8. One method he employed consisted in determining the amount of gold set free by the action of metallic indium on chloraurate of sodium. As a verification, a weighed quantity of indium was dissolved in nitric acid, and the weight of oxide of indium obtained by calcination of the nitrate determined. Indium forms a suboxide, which is obtained by an incomplete reduction of the oxide by hydrogen. By placing the bulb in a bath of melted paraffine, the phases in the reduction may be observed. About 190° , the oxide of indium becomes green, or bluish green, at the same time that water is formed; at 220° to 230° the oxide becomes grey; and about 300° it remains as a black mass, at the same time that the evolution of water ceases, only to recommence at a much higher temperature. The black mass thus obtained contains metallic globules. Separated from these metallic particles, the black mass constitutes suboxide of indium; it is pyrophoric when heated, and is transformed into oxide by combustion. The composition of this oxide is expressed by the formula In_2O . The intermediate phases through which the oxide passes are possibly due to combinations of oxide and suboxide; thus the green product obtained at 190° contains $\text{In}_2\text{O} = 5\text{InO} + \text{In}_2\text{O}$; and the grey product, which is formed about 230° , possesses the formula $\text{In}_2\text{O} = 4\text{InO} + \text{In}_2\text{O}$. When indium is heated to a temperature considerably above its fusing point, a grey pellicle of suboxide is formed, which finally takes a yellow tint; heated to redness the metal burns with a violet flame, and brown fumes of oxide are produced. The colour of oxide of indium is yellow, but at a red heat it is brown; the normal colour is reassumed on cooling. Oxide of indium appears to be infusible and fixed; it contains 82.53 per cent of indium. The salts of indium are in general soluble and difficultly crystallisable; they are colourless. The following are the characters exhibited by their solutions:—Ammonia—white precipitate soluble in excess; tartaric acid impedes the precipitation. Potassa or soda—white precipitate, soluble in excess, but soon separating again from the solution. Carbonate of ammonia—gelatinous white precipitate, soluble in excess, but soon separating again from the solution. Carbonate of soda—precipitate insoluble in excess. Carbonate of baryta—complete precipitation of indium as carbonate or oxide. Phosphate of soda—gelatinous white precipitate, dissolved by potassa solution with great ease. Sulphuretted hydrogen—yellow or white precipitate of sulphide of indium; the precipitation is complete in alkaline solutions, partial in neutral or slightly acid solutions, nil in strongly acid solutions; in presence of acetic acid the sulphide is completely precipitated. Sulphide of am-

monium—voluminous white precipitate. Oxalic acid—crystalline precipitate in neutral and concentrated solutions. Ferrocyanides—white precipitate; ferridecyanides and sulphocyanides, no reaction. Neutral chromate gives a yellow precipitate; the bichromate no precipitate. The hydrate of iodium produced by ammonia, when dried in the air, contains $5\text{InO}, 6\text{HO}$; but when dried at 100° , its composition is expressed by the formula InO, HO .

At the *séance* held on the 15th of June the following memoirs were communicated:—"On a new isomer of amyl alcohol," by M. Wurtz; "On a new alcohol, isomeric with caprylic alcohol," by M. de Clermont; "On the carbamides," by M. Gautier; "Researches on Chlorophyll," by M. Filhol; "Researches on the combustion of oil: analyses of the gaseous products of the combustion of the oil from the basin of Saarbrück," by MM. Schenker-Kestner and Mounier. M. Saix addressed a rectification to the "Theory of the pile," which he lately communicated; and M. de la Rive addressed a letter to M. Dumas, "On the theory of the phenomenon discovered by Faraday, of rotatory magnetic polarisation."

By reacting with iodide of amyl upon zinc ethyl, M. Wurtz obtained some years ago a hydrocarbon possessing the composition and the principal properties of amylene; the hydrocarbon referred to is ethyl-allyl, C_6H_{10} . The hydriodate of this body, however, boiled at 147° , while the same compound of amylene boiled at 129° . Hydriodate of amylene, it is well known, is attacked and completely decomposed, at the ordinary temperature, by oxide of silver in presence of water; the hydriodate of M. Wurtz's hydrocarbon is only incompletely attacked, behaving, under these conditions, like iodide of amyl. When one distils completely, there passes in both cases a liquid denser than water, which still contains iodine, and which, nevertheless, exhales an odour of amyl alcohol. Acetate of silver is attacked more easily by hydriodate of ethyl-allyl. The silver salt is suspended in anhydrous ether, an equivalent proportion of hydriodate added, and at the end of twenty-four hours the mixture is distilled. Above 100° , an acid liquid distils, which contains acetic acid, and an acetate corresponding to the hydriodate of ethyl-allyl. To isolate this acetate, the liquid is agitated with carbonate of soda, the oil-layer desiccated with chloride of calcium, and distilled. The acetate comes over from 133 to 135° ; it is a colourless liquid possessing an aromatic odour, which, at the same time, is not that of acetate of amyl. Potash decomposes it into acetate and isoamyl alcohol. Some of this alcohol was digested at the ordinary temperature with permanganate of potassium; distillation gave a small quantity of a neutral volatile liquid, which was treated with bisulphite of sodium. The crystals formed were compressed between blotting paper, and decomposed by distillation with carbonate of soda. A small quantity of a liquid, possessing an aromatic odour, and boiling about 103° , was obtained. This liquid, upon an analysis, gave $\text{C}=68.48$, $\text{H}=11.78$; the formula $\text{C}_6\text{H}_{10}\text{O}$ requires $\text{C}=69.76$, $\text{H}=11.16$. This analysis, and the boiling point, prove that a small quantity of acetone is formed by oxidation with permanganate; a mixture of acetic and propionic acids is also formed. The liquid from which the acetone was volatilised having been filtered and supersaturated with sulphuric acid yielded, upon distillation, an acid liquid, which was converted into a silver salt. This salt was found by analysis to contain $\text{C}=17.69$, $\text{H}=1.06$. Experiments were also made with chromic acid, and they have shown that, under the influence of oxidising agents, isoamyl alcohol (hydrate of ethyl-allyl) gives first an acetone, and afterwards splits up into propionic and acetic acids. When iodide of isoamyl is treated by acetate of silver in presence of ether, a certain amount of isoamylene (ethyl-allyl) is set free, and distils with the ether; a bromide produced therefrom, passed over from 170° to 180° . This bromide, having been heated with sodium to 100° for some days, yielded the hydrocarbon in the free state again. The hydriodate was again formed by

heating the hydrocarbon with hydriodic acid. The hydriodate thus formed was identical with the hydriodate of ethyl-allyl: it distilled over at 145° . One would conclude from this, M. Wurtz says, that the ethyl-allyl set free by the decomposition of the hydriodate, maintains its atomic grouping intact, not only after having been converted into bromide, but even after being deprived of its bromine by sodium. The alcohol described is the third isomer of the primary hydrate of amyl; the two others being the hydrate of amylene, discovered by M. Wurtz, and the secondary alcohol, obtained by M. Friedel, by adding hydrogen to methyl-butyl.

The experiments of M. de Clermont were made in the laboratory of M. Wurtz. M. de Clermont first describes hydriodate of caprylene. When caprylene is heated with a solution of hydriodic acid saturated at zero, this compound is produced; at the end of a few hours the reaction is completed, and the hydriodate is found as an oily liquid at the bottom of the vessel. The layers being separated, the product is washed first with water, afterwards with a weak solution of potash, and then dried over chloride of calcium. This liquid is submitted to fractional distillation *in vacuo*, that, coming over at 120° , constitutes pure hydriodate; the specific gravity of this distillate is 1.33 at zero, and 1.314 at 21° . By reacting in the same way with hydrobromic acid, the hydrobromate of caprylene is obtained. When hydriodate of caprylene is added to acetate of silver suspended in ether, a lively reaction ensues; iodide of silver is formed, as well as a certain quantity of caprylene and acetic acid, but a compound also, the acetate of caprylene, is obtained. Ether dissolves the fluid products. By distillation, the ether is removed; the residue is treated with water and carbonate of soda to remove the acetic acid, and dried by chloride of calcium. A liquid is thus obtained, from which the caprylene is eliminated by fractional distillation; finally, pure acetate of caprylene is obtained. It is a colourless liquid, possessing a fruity odour; its density at zero is $.822$, and at 26° , $.803$; its boiling point is inferior to that of the acetate of capryl of M. Bouis, which is 193° . Upon distilling in the oil-bath acetate of caprylene with an equivalent quantity of caustic potash, recently calcined, acetate of potash and hydrate of caprylene are obtained. The distillate requires rectification. The hydrate purified by fractional distillation was analysed, and the figures obtained led to the formula $\text{C}_8\text{H}_{16}\text{O}$; the liquid upon which the analysis was made boiled at 174° to 178° . The hydrate of caprylene is a transparent, colourless, and very mobile liquid, not oily, and possessing an aromatic odour and a burning and persistent taste; it is inflammable, and burns with a bright flame. It is insoluble in alcohol and ether; its density at zero is $.811$, and at 23° , $.793$. Hydrochloric acid does not appear to decompose the hydrate of caprylene; but the solution of hydrochloric acid, aided by heat, gives birth to the hydrochlorate of caprylene. This hydrochlorate would be a new isomer of the chloride of capryl of M. Bouis, another having been described by M. Schorlemmer,* which he obtained in treating amyl-isopropyl with chlorine.

PARIS, JULY 15TH, 1868.

Cerium.—Fluorescent liquid.—Examination of the light in certain cases of phosphorescence.—Death of M. Pouillet.

M. WÖHLER has published the following facts concerning the metal cerium. The metal itself was obtained by the following process:—A solution of the brown oxide of cerium in hydrochloric acid was mixed with an equivalent quantity of chloride of potassium and of chloride of ammonium, and the whole evaporated to dryness. The mass was then transferred to a platinum crucible, and heated till the whole of the chloride of ammonium was volatilised and fusion obtained. The fused mass was poured out, coarsely powdered, and mixed while still warm with fragments of sodium,

* *Annalen der Chem. u. Pharm.*, cxliv., p. 190; 1867.

and introduced into an earthen crucible previously heated to redness. When the contents had again fused and the excess of sodium volatilised, the crucible was removed from the fire; the deep grey resulting mass was filled with little metallic globules. In a second experiment a large piece of sodium was thrown into a red-hot crucible containing chloride of potassium, and then the coarsely powdered chloride used before. In operating in this way, a larger proportion of metallic globules was obtained, some of which weighed 50 to 60 milligrammes. These metallic globules appear to consist principally of cerium. The colour of the metal is intermediate between the colour of iron and that of lead. The metal is lustrous when polished; it is malleable. Its density is about 5.5 at 12°. Exposed to the air it loses its lustre, and becomes slightly blue. It feebly decomposes water at 100°. Hydrochloric acid dissolves it with energy; concentrated nitric acid converts it into clear brown oxide, the dilute acid dissolves it. By evaporation, a white salt is obtained which leaves, after calcination, a brown oxide, insoluble in nitric acid and in dilute sulphuric acid. Concentrated sulphuric acid slowly dissolves this oxide, forming a yellow solution which shows the reactions of ceric salts. Hydrochloric acid dissolves this oxide with disengagement of chlorine, forming a colourless solution. When a globule of cerium is heated by the blow-pipe to dull redness, the metal inflames and burns vividly, forming brown oxide; but upon submitting a globule suddenly to a very high temperature, it burns with explosion, sending out bluish sparks. Cerium powder can inflame below 100°.

When the saline mass containing the cerium globules is treated with water, a fetid hydrogen gas is liberated, and a brilliant powder of a deep purple colour is deposited, which is easily separated by washing. Dilute hydrochloric acid extracts from this powder a small quantity of metal, as well as of oxide. This body is a cerous oxychloride. Concentrated hydrochloric acid attacks it with difficulty; concentrated nitric acid dissolves it, forming a colourless solution.

A solution which is said to exhibit the most beautiful green fluorescence yet known is yielded by Cuba wood (*Morus tinctoria*). M. Ditte has prepared some alcoholic solutions, possessing remarkable fluorescent properties, with the lake of this dye wood. The process which he has found most advantageous is the following:—The lake is placed in contact with an excess of glacial acetic acid, which dissolves it completely at the end of twenty-four hours. Six times the volume of alcohol is added, and the mass filtered. The liquid thus obtained, viewed by transmitted light, is red, by reflected light, a magnificent green. Upon adding to the acetic acid solution ether quite free from alcohol, a yellow matter is precipitated, and the liquid loses its properties; the precipitate re-dissolved in alcohol, gives again a dichroic liquid. The decoction of the wood is not dichroic, but it becomes so immediately upon the addition of acetate of alumina. The fluorescent liquid, sufficiently diluted to be only slightly coloured, entirely absorbs the most refrangible part of the spectrum, from the blue to the violet. The fluorescence is not visible with the light from a lamp or gas; it is, on the contrary, very vivid with the magnesium light and in Geissler's tubes.

M. Kindt has made known the nature of the phosphorescence developed by heat in the three minerals, chlorophane, Estramadura phosphorite, and the green fluor spar. He has analysed the light emitted: the first is a simple green, the second is a yellow tinted light, composed of green, yellow and red, and the third gives two black rays, the one in the green and the other near the orange.

M. Pouillet, the eminent physicist, died on the 14th June in his 78th year. The following is a brief outline of his career:—In 1829 he became professor of physics at the *Conservatoire des Arts et Metiers*. In 1831, he succeeded Dulong in one of the chairs of physics at *l'Ecole Polytechnique*. On the 17th July, 1837, he entered the Academy of Sciences, in the physical section, and was

made an officer of the Legion of Honour. Among the researches published by him may be cited those on the dilation of elastic fluids and the latent heat of vapours, on the phenomena of interference and diffraction, on solar heat, the radiating and absorbing powers of the atmosphere, and the temperature of space. His memoirs, containing the experimental demonstration of the laws relating to electric currents, are worthy of special mention. It is hardly necessary to connect M. Pouillet's name with his *Traité de physique et de météorologie* and his *Elements de physique*.

PARIS, JULY 22ND, 1868.

Influence of the condensation of the vapour of water in experiments on the absorbent power of gases.—Persulphide of hydrogen.

At the same time, in 1861, Professor Tyndall in London, and M. Magnus at Berlin, published their experiments on the transmission of heat through different gases. These entirely independent experiments, having nothing in common in the *modus operandi*, led to results in part concordant, in part discordant. By this dual research it was clearly established that the absorbent power of different gases is extremely different. But with regard to the absorbent power of the vapour of water, Professor Tyndall asserts it to be very considerable, while M. Magnus asserts it to be insignificant. When the vapour is in the state of mist, both agree in recognising that the vapour absorbs a considerable part of the heat which it receives, but when the vapour is transparent, when it presents itself as humid air, the divergence of opinion is as great as possible. In his memoir upon the production of dew, M. Magnus has demonstrated that the emissive power of dry air is equal to that of a moist air, whence results the equality of their absorbent powers. Since then M. Wild, of Berne, has made experiments which plainly confirm those of the English physicist. M. Magnus has repeated M. Wild's experiments, and while proving their perfect accuracy, he has discovered a source of error which is a complete explanation of their results. In these experiments the thermoelectric pile is placed equidistant from two cubes of hot water, from which it is separated by brass tubes. The diaphragms enable the two currents of heat to be regulated, so that the two faces of the pile are equally heated, or the galvanometer rests at zero. This equilibrium, being obtained when the tubes are filled with dry air, should remain when moist air is substituted; but this is not the case. M. Magnus has sought the cause; this he finds in the condensation of the vapour against the internal surface of the tubes. It is a great mistake to suppose that the heat undergoes no modification in passing through the tube. When the interior is polished an infinite number of reflections are produced, and the tube sends to the pile rays which would not reach there if they were absorbed. In consequence of these multiple reflections, the pile may receive six times as much heat as if the tube did not exist. Everything which will diminish the reflecting power of the sides of the tube, and everything which will augment their absorbent power, will contribute to diminish the heat which falls upon the pile. Then this effect of the condensation of the vapour of water takes place when the tube is full of moist air. The minute layer of water which is deposited on the internal surface can have but little influence when this surface is tarnished, while it will have an enormous influence in a polished tube, an excellent absorbent being superposed to a reflecting surface. What happens further? The galvanometer being at zero with the tubes full of dry air, if moist air be introduced into the one of them, the equilibrium will subsist if the tube is blackened, while it will be immediately destroyed if the tube is internally polished. The heat will appear to be absorbed by this tube; and it is in fact, but by the bed of moisture which covers the sides, and not by the moist air which fills the tube. The effect is particularly marked when the tube is

cooler than the air, but it is observable also when the tube is notably warmer, proving that the vapour condenses on the sides, even when the space is not saturated. The vapour of alcohol behaves like water and with still greater energy; the experiment in blackened tubes proves that it exerts a sufficiently notable absorption.

Dr. Hofmann has made some experiments upon the persulphide of hydrogen. When a cold saturated solution of strychnine in strong alcohol is mixed with an alcoholic solution of sulphide of ammonium containing an excess of sulphur, brilliant crystalline flakes soon make their appearance, and twelve hours later the sides of the vessel are covered with fine needles of an orange colour, often some centimetres in length. To obtain them in a state of perfect purity, it suffices, after decanting the mother liquor, to wash with cold alcohol. These crystals are completely insoluble in water, alcohol, ether, and sulphide of carbon, in fact no solvent from which they may be recrystallised has been found. An analysis of this compound has led to the following formula: $\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2\text{S}_2 = \text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2\text{H}_2\text{S}_2$. These crystals would then be a combination of a molecule of strychnine with a molecule of a persulphide of hydrogen, of which the composition would be expressed by the formula H_2S_2 . The crystals become decolourised upon the addition of a few drops of concentrated sulphuric acid; sulphate of strychnine is formed which dissolves, while persulphide of hydrogen is separated under the form of a colourless and transparent oil. The drops of oil may be preserved for some time, but they are not long in decomposing into hydrosulphuric acid and sulphur. M. Hofmann says this combination of strychnine and persulphide of hydrogen, which can be preserved for months, leaves no doubt as to the existence of a persulphide of hydrogen (H_2S_2), which would thus be a sesquisulphide; other persulphides may, however, exist. The combination with strychnine is, as already mentioned, characterised by great insolubility; it remains to be seen whether this property can be utilised in the isolation of the alkaloid.

PARIS, JULY 29TH, 1868.

Detection of chloride in commercial bromide of potassium.
—Chlorophyl.

At a meeting of the *Société de Pharmacie*, M. Baudrimont gave an account of "A Process for Detecting the Presence of Chloride in Commercial Bromide of Potassium." The bromide to be examined is first tested for iodine. For this purpose a small quantity of the salt is dissolved in water in a test tube, and an equal volume of bisulphide of carbon added. Upon the addition of a few drops of bromine water, the bisulphide of carbon becomes coloured violet, under the influence of iodine, if this be present. When the test shows the presence of iodine, it is necessary to remove the whole of this element from the sample. This is effected by dissolving about 10 grammes of the salt in distilled water, adding bromine water until violet vapours are no longer visible upon boiling, and then testing for iodine in the manner first described. Afterwards the solution is evaporated to dryness to remove the excess of bromine, and thus one obtains a bromide of potassium free from iodide, but which may contain chloride. The remainder of the process depends upon the fact, that a given weight of chloride of potassium requires a much greater amount of a standard solution of nitrate of silver than the same weight of bromide of potassium; while the bromide for the complete precipitation of 1 gramme requires 1.428 grammes of nitrate of silver, 1 gramme of the chloride requires 2.278 grammes. For the examination of the bromide of potassium, a standard solution of nitrate of silver is first prepared by dissolving, in a litre of water, 10 grammes of the pure salt, each 1-10th c.c. corresponding to 1 milligramme of nitrate of silver. 1 gramme of the bromide to be examined, freed from iodine if necessary, is dissolved in 100 c.c. of distilled water; 10 c.c. of this solution, representing 1 gramme of bromide of potassium, would require, if pure, 14.2 c.c. of the silver solution; chloride of potassium would require 22.7 c.c.

M. Baudrimont proposes a method of making the final reaction more delicate, by adding a few drops of solution of chromate of potash to the bromide examined; the nitrate of silver added then combines with the whole of the bromine and chlorine in preference, and the complete precipitation is marked by the production of the red precipitate of chromate of silver. It is obvious that the bromide contains more or less chloride, according as the number of burette divisions (divided into 1-10th c.c.) of the silver salt required, exceeds 14.2. With a salt containing one-tenth of its weight of chloride of potassium 151 divisions are required, and with a mixture of equal weights of chloride and bromide, 185. The same method may be employed to recognise the degree of purity of several compounds. Operating as before—that is to say, dissolving 1 gramme of the material to be examined in 100 c.c. of distilled water, and taking 10 c.c. of the solution—the following numbers of 1-10th c.c. divisions required will show the purity for at least a considerable number of salts:—102 for pure iodide of potassium, 257 for cyanide of potassium, 246 for dry carbonate of potash, 290 for chloride of sodium, 119 for carbonate of soda + 10 equivalents of water, 47 for phosphate of soda + 24 equivalents of water, and 54 for arseniate of soda + 14 equivalents of water.

In a note, entitled "Researches on Chlorophyl," by M. Filhol, presented to the Academy of Sciences, he states that all the methods of preparing chlorophyl requiring the aid of acids decompose this substance, and furnish, not chlorophyl, but the products which result from its decomposition. The organic acids, the action of which is less powerful, destroy the green colour of solutions of chlorophyl; this substance splitting up into two substances, one of which separates in the solid state in the form of black flakes, while the other remains in solution, and is of a fine yellow colour. The yellow matter, treated with concentrated hydrochloric acid, is separated into a solid substance which can be isolated by filtration, and which is yellow, and a blue substance which remains dissolved. The latter becomes yellow when the acid which has produced it is saturated. The yellow solid matter which separates when the hydrochloric determines the production of the blue colour, contracts the property of becoming blue under the influence of acids, when boiled for a few minutes with potash, soda, or baryta, in contact with the air. The green parts of the plants always contain, as well as chlorophyl, the two yellow substances spoken of. It is easy to obtain them without the intervention of acids. Treatment with animal black, in insufficient quantity to completely decolourise the solution, suffices with a solution of chlorophyl; after a few trials the proper amount is arrived at, and, upon filtering, a yellow-coloured liquid is obtained, which behaves with hydrochloric acid like that obtained in decomposing chlorophyl with an organic acid. These two yellow matters exist, then, in the free state by the side of chlorophyl in all plants. The young shoots of certain varieties of fuscus which are cultivated as ornamental plants, contain these two yellow substances, without the least trace of chlorophyl. The brown solid matter which is separated upon the addition of oxalic acid to a solution of chlorophyl is rich in nitrogen; it is identical with that described and analysed as constituting pure chlorophyl, by MM. Miller and Morot. Solutions of this brown matter possess in a high degree the dichroism common to solutions of chlorophyl; solutions of the yellow matter do not possess this property. The solutions of the brown matter become orange-yellow tinted under the influence of caustic alkalies and the air; this tint soon changes and becomes a pure green by absorption of oxygen.

REPORTS OF SOCIETIES.

CHEMICAL SOCIETY.

Thursday, June 18th, 1868.

DR. WARREN DE LA RUE, F.R.S., &c., *President, in the Chair.*
In continuation of our report of this evening's proceedings

we now give abstracts of the three communications which concluded the business of the session.

Dr. W. J. PALMER contributed an interesting narrative entitled "*Observations on the Production of Nitre in India.*" The native "sorawallahs" make it the business of their lives to search for saline incrustations in and around the mud walls which enclose the primitive dwellings of the inhabitants of the north-western provinces of India. When the appearance of the soil indicates the existence of nitre they scrape off a thin layer of the impregnated earth and lixiviate it in clay vessels either with water alone or with the last washings of a previous operation, the solution thus obtained being poured into shallow pans of unglazed earthenware, and there left exposed to the sun and hot winds of a tropical climate, until the nitre crystallises out. The crude product is then partially purified by being again dissolved and recrystallised. The saltpetre is recovered in the form of dingy prismatic crystals, and common salt to the amount of from one to nine per cent, is left in the mother liquors, which upon evaporation to dryness is recovered and separately collected. The sorawallah makes periodical visits and secures fresh collections of nitre from the same spots of ground week after week, the rate of production remaining constant whilst the dwellings are inhabited, but decreasing gradually if from any cause the villages are deserted. The physical features of the nitre-producing regions were then described, and the author referred to the conditions under which most nitre seemed to be obtained; these were dependent upon the existence in the plains of India of a friable, nodular, calcareous rock called "kunkur," and water must not occur nearer the surface than twenty feet; but it was remarked that the largest yield of nitre was furnished in the four months of the year constituting the rainy season, the heavy tropical rains having the effect of washing the salt from the depths of the soil to the surface rather than of dissolving it out entirely and carrying it into the rivers. The process of nitrification commenced with the conversion of urea, &c., into nitrate of lime, under the combined influences of heat, moisture, and of the before-mentioned calcareous rock; whilst the practice of the natives of throwing their wood ashes into the common drains supplied the carbonate of potash from which, by double decomposition, the nitre was formed. These changes only occur in the neighbourhood of villages, or densely populated localities, but the process of artificial generation of saltpetre had been successfully carried out in connexion with the Indian jails. The author adds a speculation as to the influence of electrical agencies (thunderstorms) in contributing towards a more rapid formation of saltpetre.

The PRESIDENT, in proposing a vote of thanks to Dr. Palmer, invited discussion upon the electrical theory of the generation of nitric acid; whether all other circumstances being the same, most nitre should be formed during the season in which thunderstorms were prevalent.

Mr. W. H. PERKIN expressed his surprise in noticing how few sparks from a Rühmkorff coil sufficed to produce red fumes in a jar of air, especially if the temperature was somewhat raised, and the indigo test at once showed the presence of nitric acid.

Mr. DAVID FORBES had had opportunities of studying the saltpetre manufacture in several parts of the world. In order to ensure a supply of saltpetre in case of war, in Sweden, every peasant was bound to supply a certain amount of nitre to the Government as part payment of the taxes. It was the practice to rely upon wood ashes from the household fires as the source of potash, the other ingredients being nearly the same as in India, with lime added where it did not occur naturally. In the cold climate of that northern latitude there was no suspicion of lightning having any direct influence upon the generation of nitric acid. Spain formerly got much saltpetre from the plains of the south, where nitrogenous organic matter was somewhat scarce, but potash abundant, as the result of the

decomposition of the felspar of the granites. In Peru, Chili, and other parts of the continent of South America, where rain never falls, immense accumulations of nitrate of soda were known to exist; in fact, it appeared only necessary to place organic matter in contact with carbonate of lime and common salt to secure the production of the nitrate of soda or Chilean saltpetre in that climate, and in these districts all the wells were so fully charged with saline matter, that it was necessary to procure water distilled from the sea with English coal at the cost of £3 or £4 per ton for ordinary household use; even the locomotives on some South American lines had to be supplied with distilled water to avoid the formation of saline crusts in the boilers.

Dr. J. H. GILBERT was led to believe that the process of nitrification was practically independent of the oxidation of atmospheric nitrogen or of electrical action; some years ago he searched for ammonia and nitric acid in rain water which fell during a heavy thunderstorm, and found ammonia without difficulty, but the quantity of nitric acid was excessively small.

Mr. JOHN WILLIAMS took occasion to examine for sulphuric acid and ammonia in the rain water which fell during the thunderstorm in London about the end of May. The Nessler test immediately indicated the presence of ammonia, and the amount of sulphuric acid was by no means inconsiderable.

Dr. HUGO MÜLLER said it was well known that organic matter containing but little nitrogen furnished nitrate as the result of its putrescence, and it had been hinted that the oxidation of these organic matters was capable of inducing (by a sort of catalytic action) the formation of nitric acid from the surrounding atmospheric nitrogen. Schönbein proved that nitric acid was formed merely by bringing nitrogen gas in contact with flame.

Dr. GUTHRIE was desirous of assuring himself that the proceeds of the sale of nitre more than covered the cost of production under favorable circumstances of native labour. Some years ago he proposed to the Government authorities to collect saltpetre in the Mauritius, for the town lies low and near the sea, and there were difficulties in the way of securing good drainage. Not only as a commercial speculation, but as a sanitary measure, the removal of this sewage, and the conversion of it, if possible, into saltpetre seemed to be important; his advice was not adopted, and since that time his views had received confirmation by the fearful ravages of disease and high rate of mortality which had occurred in the island.

Dr. J. ATTFIELD conceived that the largest production of nitre would not coincide with the periods when thunderstorms most frequently succeeded each other, but that a necessary interval must elapse to allow time for the oxidation to proceed.

Dr. ODLING referred to an anomaly in the fact that starch paste, although destitute of nitrogen, gave off ammonia during its fermentation. For his own information he enquired whether the great bulk of nitre imported from India is made by the manual collection plan which had just now been described?

Dr. PALMER supplemented his previous remarks by making a few statements respecting the depth at which water ordinarily occurred in the large tracts of country near the Himalayas as compared with other localities in the plains of the Ganges. There could be no doubt about the fact that nitre was collected in much greater quantity during the four months of the rainy season than at other times, but whether this circumstance was due to the more speedy recovery of the salt, already formed, by the solvent action of water resulting from heavy rains penetrating the earth to a greater depth, and by subsequent evaporation becoming reabsorbed to the surface; or to a direct influence of electrical action in promoting the nitrification, seemed to him (the speaker) well worthy of discussion, and he was only glad to have started a subject of so much interest to the members of the Society. For his own part he now thought that the

lightning had very little influence in contributing to the formation of saltpetre. In reply to Dr. Odling he would state that all the saltpetre which came to England was the produce of the small collections brought in by the "Sorawalabs," who for centuries past and for many succeeding generations had carried on this business in the Bengal provinces.

Dr. F. GUTHRIE exhibited and described a little "Instrument for Maintaining a Constant Temperature," where gas is available. It consists of a bulb containing air connected by an elbow-piece to an upright glass tube filled with mercury, the column of which rises to a greater height when the air in the bulb suffers expansion by heat. The ascent of the mercury is used to cut off partially the communication between the gas burner and its supply; it does this merely by rising into the bend of a U-tube, through which the gas is conducted. The whole apparatus admits of adjustment for use at any required temperature by depressing an iron wire piston into the mercury reservoir. The position of this sliding piston may either be central or extra-lateral.

Mr. HERBERT McLEOD instituted a comparison between this instrument and Bunsen's thermostat; and Dr. E. J. MILLS mentioned some points of similarity to Kemp's gas regulator. A form of instrument sketched in Greville Williams's *Chemical Manipulation* was likewise referred to.

The SECRETARY then read some *Mineralogical Notices*, by Professor A. H. Church, M.A., which included descriptions and analyses of chalybite, diallogite, and woodwardite.

I. *Chalybite*.—The sample examined was found by Mr. Wm. Vicary, F.G.S., as a globular mass in the interior of a large flint from Haldon, near Exeter. It was crystalline with radiated structure, and yellowish grey in colour. Upon analysis it proved to be almost chemically pure ferrous carbonate, and the iron determined by the permanganate method gave nearly the theoretical proportion.

II. *Diallogite*.—A pale rose-red variety, of exceptional purity, obtained from Mr. Talling, of Cornwall. It furnished, on analysis, results indicating the following composition:—

Carbonate of manganese.....	97.65
Carbonate of iron.....	2.65
	100.30

III. *Woodwardite*.—The author answers the objections of M. Pisani (*Comptes Rendus*, 1867, p. 1142), who believes this mineral to be a mixture of langite and allophane, by asserting that clean specimens of woodwardite do not contain so much as 1 per cent. of silica, and that they exhibit sufficiently definite chemical and physical characters to justify their being considered a distinct mineral species. Viewed under the microscope, the mineral appeared to be of uniform structure throughout, which is not the case with the samples analysed by M. Pisani, nor with those of an olive-green colour previously examined by Messrs. Church and Warrington, to which they hesitated to assign a formula. The analytical results of this obviously-mixed specimen are now published, for comparison with the numbers stated in the *Comptes Rendus*.

Mr. DAVID FORBES complained that chemists frequently omitted to give the specific gravity, and other physical characters of great importance, in deciding the claims of a mineral to be considered a new species.

Dr. HUGO MULLER considered the mode of occurrence in the mine a matter of greater consequence than had been usually allowed. With many of these Cornish minerals the exact locality and mode of occurrence were kept a profound secret, and samples obtained from the dealers might frequently give concordant results on analysis, merely from the circumstance that they were all portions of the same mineral slab.

Mr. WM. HUSTLER said he had great doubts about the existence of woodwardite as a distinct mineral.

Mr. R. WARRINGTON defended woodwardite, on the ground of all the analyses showing a general agreement. The

chemist had but small chance of tracing the origin of a mineral in the mine.

The PRESIDENT, after moving a vote of thanks in favour of the respective authors, adjourned the meeting until the first Thursday in November.

ACADEMY OF SCIENCES.

PARIS, JUNE 8TH, 1868.

Researches on the salts of thallium.—Action of the voltaic arc on the earthy oxides.—Nitroprussiate of potash as a test for alkalinity.—Production of the diamond.

THE following is a list of the memoirs of chemical interest communicated to the Academy of Sciences at the *séance* of the 8th: "Chemical, Optical, and Crystallographic Researches on the Salts of Thallium," by MM. Lamy and Des Cloizeau; "Action of the Voltaic Arc on the Earthy Oxides," by M. Le Roux; "On the Compression of Saturated Vapours," by M. Cazin; "On the Employment of Nitroprussiate of Potash as a Test for Alkalinity," by M. Filhol; "On Chloropropionic Acid," by M. Buchanan; "On the Production of the Diamond," by M. Saix, by the same author, a note entitled, "Theory of the Pile, its Laws," a note in reference to the principle of a new electrometer founded upon inductive electricity; "A Note on the Water of the Mediterranean, the Water of the Ports of Marseilles, and the Gases disengaged from the latter," by M. Commaille, completes the list.

It is well known that nitroprussiate of potash can serve to distinguish a solution containing free hydrosulphuric acid from a solution of an alkaline sulphide; while hydrosulphuric acid undergoes no apparent change when mixed with a solution of nitroprussiate of potash, a solution of an alkaline sulphide thus treated, becomes coloured, immediately, deep blue or violet. M. Béchanp has proposed to employ nitroprussiate of potash as a reagent to distinguish mineral waters in which the sulphur occurs as hydrosulphuric acid from those containing a sulphide. MM. Mialhe and Lefort, in investigating the chemical composition of some warm waters, have had recourse to this reagent to determine the state in which the sulphur existed in these mineral waters. The great alterability of the waters of certain mineral springs, the facility with which they evolved a relatively large quantity of sulphur in the state of hydrosulphuric acid, had impressed M. Filhol with the idea that they contained sulphide of calcium. He had therefore attempted the use of nitroprussiate of potash, but difficulties here occurred, which led him to examine carefully the action of this reagent upon certain solutions, and to observe that a mixture of nitroprussiate and hydrosulphuric acids constituted a reagent of great sensibility for the detection of alkalinity in any solution. Such a mixture is not only coloured by the presence of caustic alkalies, but also under the influence of alkaline carbonates, bicarbonates, borates, or silicates; it becomes coloured likewise a very intense blue, when phosphate of soda, or any other salt having an alkaline action upon litmus tincture is present. M. Filhol remarks that to see hydrosulphuric acid act upon a solution of phosphate of soda so as to produce sulphide of sodium is certainly curious. Nitroprussiate of potash thus is shown to be a reagent, permitting of the discovery of the phenomena of decomposition, which takes place between an acid and a salt in solution where all the products of the reaction remain dissolved. These facts evidently have interest also in regard to the study of sulphurous waters, either natural or artificial. It would be no longer permitted now to say that a mineral water only contained hydrosulphuric acid in the free state, if at the same time this water contained alkaline carbonates, borates, silicates, and phosphates. A more or less considerable quantity of sulphide in fact is produced when these salts are mixed with hydrosulphuric acid. In examining the waters of the Ax (Aix) with nitroprussiate of potash, M. Filhol was surprised to see the water from the warmest springs (tem. 75° to 76° C.) behave like a solution of free hydrosulphuric acid, when he had a multitude of reasons to suppose that the water contained an alkaline sulphide in solution. Not less surprised was he

to find the same mineral water cooled out of contact with the air, behave with the nitroprussiate as a solution of an alkaline sulphide. We may expect some further details.

M. Saix indicates, in his memoir "Upon the Production of the Diamond," a process which he believes could be employed for the "manufacture of black, coloured, and colourless diamonds." This process is founded on the principle that a current of chlorine, or of hydrochloric acid gas, passing over fused cast-iron, forms perchloride or protochloride of iron, both of which volatilise, leaving the carbon present in the mineral intact, since the chlorine ought not to unite directly with the carbon. The crystallisation of the carbon could thus be effected, according to the author, following the general rule, for crystallisation is produced in a solution of a substance susceptible of crystallisation whenever the solution is evaporated. The size of the crystals depends always upon the slowness of the evaporation. Your readers will doubtless praise the disinterestedness of a savant who thus leaves others to gather the golden apples.

PARIS, 1868.

Electro-capillary phenomena, separating media and the influence of colouring matter.—Dilation of solid bodies by heat.—Two isomeric phenols.

THE following memoirs brought before the Academy at a recent meeting have not yet been noticed:—Fifth memoir on electro-capillary phenomena; third part, separating media and the influence of colouring matters, by M. Becquerel; on the dilation of solid bodies by heat, by M. Fizeau; note on two isomeric phenols, the xyenols, by M. Wurtz; facts concerning the history of persulphide of hydrogen, by M. Hofmann; note on the existence of starch in the yolk of egg.

M. Becquerel prepared parchment paper with ordinary filter paper by immersing in sulphuric acid containing 15 per cent of water, withdrawing immediately, and washing with a large quantity of water. A tube closed by a diaphragm of this material, and filled with a saturated solution of nitrate of lime, was plunged into a solution equally saturated with sulphate of soda. Stalactites formed on the under surface of the paper, composed of crystallised double sulphate of soda and lime. These stalactites are of variable diameter, varying according to the size of the pores which allow the passage of the nitrate of lime. By diminishing the size of the capillary tubes, the passage of the liquid is indefinitely retarded, until it at length becomes appreciable. There is a point, in regard to the diameter of these capillary tubes, where the electro-capillary force ceases to act, and where complete filtration ensues; a single pore is sufficient to produce this effect. For this reason it is necessary that the parchment paper be uniform. Some experiments were made with siliceous diaphragms. Columns of sand, varying from 5 millimetres to 5 centimetres in height, kept in position in each case by a tuft of asbestos, were substituted in the former apparatus. In operating in Dutochet's way, with solution of sugar, solution of salt, and distilled water, simple filtration took place, instead of a strong endosmose with the organic membrane; but this was not the case when a saturated solution of sulphate of soda was placed in the tube, and in the outer vessel another of chloride of barium, an endosmose of 2 centimetres resulting in two days. No precipitate is seen in the outer vessel, so that there is only a displacement of the solution. In placing in a tube closed with a diaphragm of parchment paper a solution of sugar or of salt, coloured with litmus or other colouring matter, and water in the outer vessel, a strong endosmose is produced in the tube, and at the end of a few days traces of colour in the water are only seen with difficulty; the colour is completely arrested by the membrane.

M. Wurtz described some experiments having for their object the transformation of xylene into a xylenol; they have led to the interesting result, that this carbide of hy-

drogen gives birth to two phenols, isomeric with each other, a solid xylenol and a liquid xylenol. Xylene boiling at 139° , and which had distilled entirely between 138° and 140° , was agitated with double its volume of ordinary sulphuric acid; it dissolved, and to complete its solution a gentle heat was applied by the water-bath. The sulphoxylenic acid thus formed was converted into a barium salt, then into a potassium salt, and the latter fused in a silver crucible with double its weight of potash. The xylenol thus formed was separated by hydrochloric acid and dissolved in ether. The liquid obtained by the evaporation of the ether distilled over at about 210° . Owing to the lowness of the temperature last winter, a mass of crystals took the place of the liquid. These crystals were separated from the mother liquor by compression between blotting paper. After solution in ether, and another evaporation—made by allowing nearly the whole of the ether to evaporate spontaneously, and then depositing the residue upon the blotting paper used before—and finally distilling, pure solid xylenol was obtained. On the other side, the papers impregnated with the crude liquid product were distilled with water. The steam carried over a liquid product nearly insoluble in water. This product, dried and purified by distillation, constitutes the liquid modification of xylenol. *Solid xylenol*, $C_{11}H_{10}O$ —This body is deposited from the ethereal solution in brilliant colourless plates, which melt at 75° . The liquid enters into ebullition and boils constantly at 213.5° , the bulb and the stem plunging into the vapour. *Liquid xylenol*, $C_{11}H_{10}O$ —This is a colourless, powerfully refracting liquid, possessing a strong odour of phenol. Its density at zero is 1.036. It boils at 211.5° , under a pressure of 759 mm., the thermometer as before. Xylenol is miscible in all proportions with alcohol and ether; it is very slightly soluble in water, and is itself able to dissolve a small quantity of water. M. Wurtz reminds chemists that this isomerism should be able to exist in the case of xylene itself, according to the beautiful theory of M. Kekulé.

Watts's *Dictionary of Chemistry* has been very favourably reviewed in *Les Mondes*. You will doubtless feel flattered to hear that Father Hamy, to whom M. L'Abbé Moigno had surrendered the task of examining this work, noticing your review, referred in eulogistic terms to the *CHEMICAL NEWS*. He said, "Since I have mentioned this journal I cannot refrain from recommending it to all who pursue the study of chemistry; it is a very excellent weekly journal."

PARIS, JUNE 22ND, 1868.

Researches on electrolysis.—Laws of induction.—Secondary currents.—Preparation of crystallised sulphides of iron and of manganese.—Researches on the dissociation of certain ammoniacal chlorides.

THE following memoirs were brought before the Academy at the meeting on the 22nd of June:—"Researches on Electrolysis," by M. Favre; "On the Laws of Induction," by MM. Jamin and Roger; "On Secondary Currents and their Applications," by M. Planté; "On the Preparation of Sulphides of Iron and of Manganese," by M. Sidot; "Researches on the Dissociation of certain Ammoniacal Chlorides;" "Note on the Purification of Sulphide of Carbon," by M. Commaille.

In a former note, M. Sidot showed how certain natural sulphides could be reproduced with the forms they present in nature; with the processes then used he has essayed the preparation of other sulphides, in particular those of iron and manganese. With iron two sulphides were obtained, the protosulphide crystallised, and the magnetic sulphide possessed of magnetic polarity. To obtain this result, a current of dry sulphuretted hydrogen is made to pass over artificially prepared magnetic oxide of iron, heated to bright redness. At the commencement of the operation, aqueous vapour and sulphurous acid are disengaged, and at the end of about two hours, the whole of the oxide is transformed into sulphide, in a state of perfect fusion. Upon

raising the temperature then, a considerable evolution of sulphur vapours is noticed, indicating that the sulphide formed becomes decomposed under these conditions. After cooling, the porcelain tube which has served for the operation is broken and the cold part will be found lined with fine crystals of hexagonal sulphide of iron. The crystals of hexagonal sulphide present, like those of blende, a variable colour from black to citron yellow. M. Friedel, who has examined them, has found their form to be that of the hexagonal prism, modified by the tangent prism; unfortunately these modifications were not capable of measurement. These crystals present clearly the characters of the protosulphides, with which they are isomorphous; this sulphide is not at all magnetic. Its formation is easily explained, observing that the magnetic oxide of iron gives rise to the corresponding sulphide Fe_2S_3 , and this sulphide at a very high temperature yields sulphur which volatilises, and protosulphide of iron, FeS , which sublimes and crystallises in hexagonal prisms on the cooler portions of the tube. The residue in the porcelain tube not sublimed is magnetic sulphide of iron, Fe_3S_4 ; this sulphide is not only magnetic, but possessed of magnetic polarity. The crystallised protosulphide of manganese can be prepared in passing a current of dry sulphuretted hydrogen over sulphide of manganese. By this process greenish yellow hexagonal prisms have been obtained; with polarised light they behave like hexagonal blende; at the same time small lamellar plates, in the form of crosses or squares, are produced, shown very clearly in the specimens placed under the eyes of the Academy.

Various investigators have shown that a great number of metallic chlorides can absorb dry ammonia gas and form compounds; these compounds are usually capable of ceding the gas they have absorbed upon exposure to the atmosphere, or better when slightly heated. These are some of M. Isambert's results. Chloride of silver placed in a current of ammonia gas absorbs an amount varying with the temperature to form two compounds: (1) above 20° it yields the compounds already known to exist $2\text{AgCl}_3\text{NH}_3$; (2), between zero and 15° , a compound not yet signalled is formed, AgCl_3NH_3 . The study of the tension of the ammonia gas disengaged from either of these combinations, shows that the pressure remains constant when the temperature remains constant; when the temperature is raised the tension of the ammonia increases. Chloride of calcium absorbs ammonia gas in very large quantity; besides the two compounds already known, M. Isambert has obtained one expressed by the formula CaCl_4NH_3 . This compound, as well as the one with two molecules of ammonia, has a tension of dissociation, constant for the same temperature. Iodide of calcium forms a compound, CaI_3NH_3 , which follows the same laws as the bodies previously described. Chloride of zinc and chloride of magnesium furnished two new compounds, ZnCl_3NH_3 , and MgCl_3NH_3 . These bodies behave exactly as those already described. Some experiments were also made with bodies which absorb ammonia without forming combinations, bodies of the nature of carbon. Here the tension of the ammonia gas disengaged was found to be no longer constant with the temperature constant; it diminished rapidly when the quantity of gas contained in the apparatus was diminished.

PARIS, JUNE 29TH, 1868.

Phosphate of Lime.—Action of ether in contact with iodide of potassium.—Origin of peridotite products.—Density of calomel vapour and formula of the chlorides of mercury.

On the 29th of June, the following communications were made to the Academy:—"On the Diathermancy of Chloride of Potassium," by M. Magnus; "Facts concerning the History of Phosphate of Lime," by MM. Dussart and Pelouze; "On the Manner in which Ether Acts in contact with Iodide of Potassium," by M. Houzeau; "On the Eruptive Origin of Peridotite Products," by M. Bertrand de Lom; "On the Distribution of the Flow of Heat, and of Conductibility in

Homogeneous Crystalline Media," by M. Morin; "On the Introduction of a Resistance, termed Dynamic, in the explanation of Phenomena of Induction," by M. Le Roux; "On the Density of the Vapour of Calomel," by M. Debray; "New Researches on the Action of Dry Hypochlorous Acid on a Mixture of Iodine and Acetic Anhydride," by M. Schützenberger; "On the Property of Oxygen of Re-lighting Ignited Bodies," by M. Robinet; "Remarks on the Various Causes which may lead to Feeble Variations in the Indications of Balances."

In their memoir, entitled "Facts Concerning the History of Phosphate of Lime," MM. Dussart and Pelouze remark that when gelatinous phosphate of lime is placed in a vessel containing some litres of water saturated with carbonic acid, after some time the carbonic acid will be found to have disappeared in part, and the phosphate itself to have sensibly diminished. The transparent liquid obtained by filtration, gives by heat a crystalline precipitate, composed of phosphate and carbonate of lime. The phosphate formed is no longer tribasic, but a bibasic phosphate due to the elimination of an equivalent of base from the preceding salt. To demonstrate this, they take some of the precipitate and expose it to a moderate heat, so as to remove all the water which the salt contains, without, however, decomposing the carbonate; this operation converts the bibasic phosphate into pyrophosphate. After cooling, the substance is dissolved in cold hydrochloric acid, and precipitated by ammonia. In an experiment the ignited precipitate weighed 71; it was again digested with dilute hydrochloric acid for some hours, treated with chloride of calcium, and finally precipitated by ammonia. This precipitate, after ignition, weighed 62; the difference 11 represents the exact quantity of oxide of calcium sufficient to transform the pyrophosphate into bibasic phosphate. Tribasic phosphate attacked by carbonic acid always gives rise to a product mixed with carbonate of lime. When a solution of acid phosphate of lime is mixed gradually with precipitated carbonate of lime, effervescence takes place, at the same time that a crystalline white solid is deposited. If the proportion of carbonate of lime is sufficient, the liquor is almost completely deprived of acid phosphate; washing first with acid phosphate, and afterwards with distilled water, brings the salt to a sufficient state of purity for analysis. Thus prepared, the bibasic phosphate of lime is a white granular crystalline body, slightly soluble in distilled water (28 in 1000), more soluble in water charged with carbonic acid (66 in 1000); it contains six equivalents of water, one of which is water of constitution, the composition being expressed by the formula 2CaO , HO , PO_3 , 5HO . It differs from that obtained by double decomposition with phosphate of soda and chloride of calcium, which contains only three equivalents of water. Bibasic phosphate of lime is produced either by acting upon tribasic phosphate of lime with carbonic acid, or by reacting with acid phosphate of lime on the carbonate.

The density of the vapour of subchloride of mercury has been determined by Mitscherlich, and more recently by MM. Deville and Troost; the number found by these later experimenters ($D=8.21$) differs little from the theoretical number 8.15, calculated in supposing that the formula HgCl corresponds to four volumes of vapour ($\text{Hg}=200$, $\text{Cl}=35.5$, $\text{H}=1$, representing two volumes). But chemists, who with M. Wurtz adopt modern ideas upon atomicity, represent calomel by the formula Hg_2Cl_2 , and as, on the other hand, they do not admit that the formula of a body can correspond to 3 volumes of vapour, they suppose that the protochloride of mercury is split up at the temperature at which its vapour density is taken into metallic mercury, Hg , and bichloride, HgCl_2 , occupying each four volumes of vapours. M. Debray quotes a statement of M. Wurtz to this effect, from *Leçons de la Société Chimique*, 1864, p. 163. "It is easy to demonstrate," M. Debray continues, "on the contrary, that calomel is not decomposed, even partially, into mercury and bichloride, at least under the circumstances in which its vapour density is taken, since a plate of gold introduced into the

flask where this density was taken, at 440° (temperature of boiling sulphur), maintained all its lustre and malleability. If any assurance of the delicacy of this test were required, one need only bring a plate of gold in contact with the vapours of biniodide of mercury, at a temperature approaching dull redness; this compound commencing to dissociate in these conditions, the plate of gold is found, after the experiment, whitened by the mercury, and so brittle as to be reduced to powder by the pressure of the fingers. Consequently, calomel suffers no dissociation, not even a partial dissociation at 440° ; and if its formula were well established to be Hg_2Cl_2 , it would have to be joined to the list of b. dies whose vapour densities correspond to eight volumes." Such are M. Debray's conclusions.

ROYAL INSTITUTION OF GREAT BRITAIN.

General Monthly Meeting, Monday, July 6, 1868.

Sir H. HOLLAND, Bart., F.R.S., in the Chair.

JOHN GLAS SANDENAN, Esq., was elected a Member of the Royal Institution.

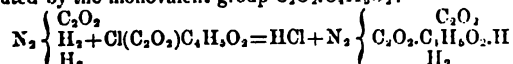
The Managers announced, that, in conformity with the Deed of Endowment, they had appointed William Odling, Esq., M.B., F.R.S., Fullerian Professor of Chemistry, in the room of the late Professor Faraday.

The presents received since the last meeting were laid on the table, and the thanks of the members returned for the same.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Preparation of Carbonic Oxychloride.—Th. Wilm and G. Wischin recommend the following as the most convenient method for preparing phosgen gas:—Pure carbonic oxide and chlorine are conducted through a properly perforated india-rubber stopper into a flask of white glass of about 10 litres capacity, the tubes reaching to the bottom of the flask. The mixed gases then pass through a third shorter tube to the bottom of a second, and from there to a third flask of similar size. The gas issuing from the last is free from chlorine, and contains only traces of carbonic oxide, if the two gases, as is advisable, enter the first flask in such proportions that the volume of carbonic oxide is slightly in excess. The operation has, of course, to be performed in sunlight. (*Zeitschr. Chem.*, N. F., iv., 5).

Synthesis of the Ether of Allophanic Acid.—Th. Wilm and G. Wischin.—On heating equal eqs. of urea and ethylic chlorocarbonate in a small flask connected with a reversed Liebig's condenser, the ethylic allophanate of Liebig and Wöhler is formed, from which synthesis the authors conclude that this body is urea, in which 1 atom of H is substituted by the monovalent group $\text{C}_2\text{O}_2\text{C}_4\text{H}_5\text{O}_2$:—



In a note to this communication, Kolbe adds that this ether of allophanic acid might be considered as carbaminic ethide in which amide is replaced by urea minus 1 atom of hydrogen. (*Ibid.* 5).

Reduction of Indigo-Blue.—A. Paeyer.—Indol may be obtained directly from indigo by treating the latter with tin and chlorhydric acid. A green substance, a compound of indigo-white with suboxide of tin, is first formed, which on continued heating becomes yellow, being converted into a compound of tin with a further reduced indigo-blue. This yellow compound, mixed with little water and powdered zinc, when heated gives out indol in large quantities. Indigo-blue may be considered as composed of two molecules of indol joined together by two atoms of oxygen— $(\text{C}_8\text{H}_7\text{C}_2\text{HN})_2\text{O}_2$. During the reduction to indigo-white one atom of oxygen is taken

out, and the compound $(\text{C}_8\text{H}_7\text{C}_2\text{NH})\text{O}(\text{C}_8\text{H}_7\text{C}_2\text{NH}_2)$ formed. Further reduction removes the second atom of oxygen, the two molecules separate, and an isomer of oxindol, $\text{C}_8\text{H}_7(\text{C}_2\text{NH}_2\text{OH})$, is obtained. (*Deut. Chem. Ges. Berlin*, 1868, 17.)

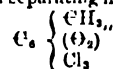
Determination of Sulphur in Organic Compounds.

—R. Otto determines sulphur in organic compounds by heating them in a short combustion tube mixed with chromate of copper. The chromate is prepared by precipitating a solution of potassic bichromate (which must be quite free from sulphur) with cupric nitrate, and washing the precipitate twice. It is then dried at 100°C . The combustion must be proceeded with slowly, and the front part of the tube heated just high enough to prevent condensation of moisture. The contents of the tube, after cooling, are dissolved in chlorhydric acid, digested with alcohol, and, after complete reduction, filtered and precipitated with baric chloride. It is the principal advantage of the use of this copper salt over that of the mixture of sodic carbonate and potassic nitrate, that from the absence of any action on the combustion tube, no silicic acid becomes mixed with the products of the reaction—*Ann. Chem. Pharm.*, cxlv., 25.)

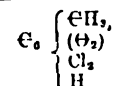
Artificial Methylic Alcohol.—E. Linnemann.—Methylamine was prepared from cyanhydric acid, with slight modifications, according to Mendius's method, and converted into methylic alcohol by means of argentic nitrite in the manner described on a former occasion (*vide* CHEMICAL NEWS, No. 436, p. 181, *Am. Repr.*, June 6, '68, p. 286). The corrected boiling point of the pure alcohol at the normal barometrical pressure (670 m) is 67.1°C , sp. gr. at $21^{\circ} = .8574$. The iodide of the alcohol has the sp. gr. at $25^{\circ} = 2.269$, and boils under a pressure $.738\text{ mm}$. at 42.5° . These observations prove the identity of the alcohol obtained from cyanhydric acid with the methylic alcohol from wood spirit—(*Ann. Chem. Pharm.*, cxlv., 42).

Conversion of Methylic into Ethylic Alcohol.—A. Sierich.—Acetonitrile, prepared by acting upon potassic methylsulphate with potassic cyanide, was converted into ethylamine, and from the nitrite of that base, alcohol was obtained. This alcohol was found to be a mixture of ethylic and methylic alcohol, in the approximate proportion of 4 to 1. The author explains the presence of the latter by the assumption that during the decomposition of the nitrite of ethylamine alcohol has been regenerated.—*Ann. Chem. Pharm.*, cxlv., 46.)

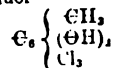
Toluquinone.—C. Graebe and E. Borgmann.—The authors have obtained from cresylic alcohol, by treatment with potassic chlorate, a mixture of chlorinated quinons of toluol, which they succeeded in separating into trichlorotoluquinone—



and dichlorotoluquinone—



Their physical properties resemble closely those of the chloroquinones. Sulphurous acid converts the trichloro-compound into trichloroxytoluol—

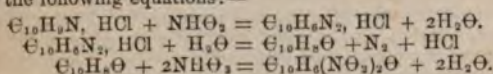


—*Zeitschr. Chem.*, N.F., iv., 118.)

Detection of Nitroglycerine.—To detect nitroglycerine in cases of poisoning, A. Werber proceeds in the following manner:—The organic material to be tested is extracted with ether or chloroform, the extraction mixed on a watch glass, with two or three drops of pure aniline, and evaporated upon the water-bath. A few drops of concentrated sulphuric acid are then added, when, if nitroglycerine is present, a purple colouration appears which

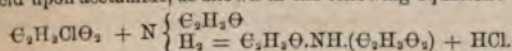
changes to a dark green on dilution with water. As little as .001 grain of nitroglycerine may thus be identified.—(*Schmidt's Jahrb. d. ges. Med.*, 1867; and *Zeitschr. Analyt. Chem.*, vii., 158.)

Dinitronaphtol.—C. A. Martius.—Chlorhydrate of diazonaphtol, $\text{C}_{10}\text{H}_8\text{N}_2$, HCl, is formed by the action of potassic nitrite upon a diluted and acid solution of chlorhydrate of naphthylamine, $\text{C}_{10}\text{H}_7\text{N}$, HCl. If a solution of chlorhydrate of diazonaphtol is mixed with nitric acid and boiled, a violent reaction takes place, during which nitrogen is set free, and on cooling, yellow crystals separate, which consist principally of dinitronaphtol, $\text{C}_{10}\text{H}_6(\text{NO}_2)_2$. The formation of this compound is illustrated by the following equations:—

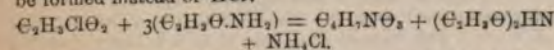


Dinitronaphtol is almost insoluble in boiling water, difficultly soluble in alcohol, ether, or benzol. It is a strong acid, decomposing carbonates readily. Reducing agents convert it into a basic compound of the composition $\text{C}_{10}\text{H}_8(\text{NH}_2)_2\text{O}$ as described by the author and P. Greiss (*Ann. Chem. Pharm.*, cxxxiv., 375). Dinitronaphtol is a valuable yellow dye, and is now extensively used as such.—(*Akad. z. Berlin*, 1867.)

New Synthesis of Aceturic Acid.—N. Tazukowitsch.—The action of chloracetic acid upon benzamide gives rise to the formation of hippuric acid, as described by the author on a previous occasion (*vide* CHEMICAL NEWS, No. 411, p. 208, *Am. Repr.*, Dec. '67, page 318). In a similar manner aceturic acid may be obtained by acting with chloracetic acid upon acetamide, as shown in the following equation:—



In order to avoid the injurious action of the free HCl, an excess of acetamide has to be taken, when NH_4Cl will be formed instead of HCl:



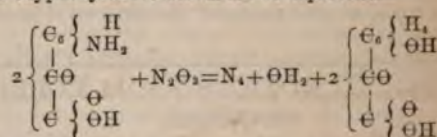
Chloracetic acid and acetamide have to be heated together to 150–155° C. for three hours. The liquid portions are then poured off from the crystals and mixed with an excess of ether, which causes an oil to separate. The aqueous solution of this oil is neutralised with calcic carbonate, and from the calcic aceturate the acid is liberated by adding an equal proportion of oxalic acid.—(*Zeitschr. Ch.*, N. F., iv. 79.)

Dibromide of Cholesterin.—W. Moldenhauer and T. Wislicenus.—Well purified cholesterin, dissolved in carbonic disulphide, and treated with bromine until the latter ceases to disappear, is converted into a dibromide, $\text{C}_{26}\text{H}_{44}\text{Br}_2$. This compound, which is insoluble in water, is readily purified by recrystallisation from a mixture of alcohol and ether. On reduction with sodium-amalgam no substitution of bromine by hydrogen takes place, but cholesterin is regenerated.—(*Naturf. ges. Zürich.*, 1867, 166.)

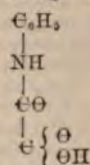
Preparation and Determination of Cantharidin.—A. Fumouze.—Powdored cantharides are macerated with chloroform for twenty-four hours, and this treatment is repeated twice with fresh quantities of solvent, the residue having been well squeezed each time. The collected solutions are then distilled, and the dark green residue treated with carbonic disulphide which dissolves fatty, resinous, and other matters, and precipitates the cantharidin. The precipitate is thrown on a filter, washed with carbonic disulphide, and recrystallised from chloroform. The same process, omitting the final recrystallisation, may be used for the quantitative estimation of cantharidin in cantharides. The average quantity found was from four to five grammes in one kilogramme.—(*Journ. Pharm.*, vi. 161.)

On the Probable Identity of Methylc Aldehyd with Dioxymethylene.—A. Geuther.—Hofmann in his researches on methylc aldehyd (*Comptes R.*, lxx., 555), mentions a crystalline body of the composition $\text{C}_2\text{H}_4\text{S}$, which he obtained by treating the original liquid with sulphuric hydride, and boiling the oil thereby formed with chlorhydric acid. The composition of these crystals and their properties, as described by Hofmann, are identical with those of a compound first discovered by Girard as a product of reduction of carbonic disulphide, and afterwards obtained by A. Flusemann from ethylenic sulphide by heating to 150° C., and called by that chemist dimethylenic sulphide. Should the compound of Hofmann be identical with dimethylenic sulphide, the existence of methylc aldehyd amongst the products of oxidation of methylc alcohol would become doubtful in proportion as that of dioxymethylene would gain in probability (*Zeitschr. Ch.*, N. F. iv., 159).

Oxanilic Acid.—A. Claus has investigated the reaction between nitrous acid and oxanilic acid, in order to decide the question whether the two carbon nuclei of the latter acid—that of oxalic acid on the one hand, and that of aniline on the other—are held together by direct union, or through the interposition of the nitrogen atom. If the former alternative is the correct one, the action of nitrous acid will confine itself to the group NH_2 , and the formation of an oxyphenyloxalic acid must be expected:—

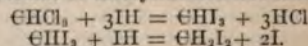


The experiment, however, proved that this is not the case; but, accompanied by a copious evolution of nitrogen, a complete dissolution takes place, ending in the formation of carbolic and oxalic acid. The atomic constitution of oxanilic acid, therefore, must be regarded as—



—(*Journ. pr. Chem.*, ciii., 54.)

Conversion of Organic Chlorides into Iodides.—A. Lieben.—The method for converting organic chlorides into iodides, which is applicable in many cases, is based on the fact that double decomposition takes place when an organic chloride is treated with concentrated iodhydric acid. Thus ethylic chloride, heated with HI of 1.9 sp. gr. in a sealed tube to 130° C., is readily converted into iodide. On the other hand, ethylic iodide may be reconverted into chloride, though extremely slowly and imperfectly, by heating with chlorhydric acid. Chloroform and iodhydric acid, at 130°, give iodide of methylene and free iodine:



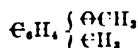
The method is less successful in the case of aromatic chlorides, on account of the high temperatures required to start the reaction, temperatures at which the iodides cannot exist.—(*Akad. Wein. and. Journ. pr. Chem.*, civ., 59).

On the Vapour Density of Ammonic Sulphide.—A. Horstmann has made some experiments on the vapour density of ammonic sulphide, according to Bunsen's method (*Ann. Chem. Pharm.*, cxli., 273), the results of which differ from those obtained by Deville and Troost (*Comptes R.*, lvi., 895). He finds that ammonia and sulphuric hydride, at the temperature employed in his experiments—ranging from 564°

C. to 58° —do not combine, in whatever proportion they are mixed.—(*Ann. Chem. Pharm.*, vi. Suppl. 74.)

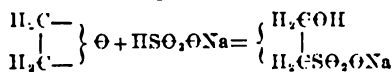
Note on Phosphoric Sulphochloride.—A. von Flemming.—Phosphoric sulphochloride, as obtained by treating sulphurous chloride with phosphorus, and distilling the product of the reaction (*Chevier, Journ. de Pharm. et de Chem.* (4), v., 117), is not pure. It may, however, be rendered chemically pure by shaking it with little water. The heavy layer which collects underneath the water is dried at 110° C., and distilled.—(*Ann. Chem. Pharm.*, cxlv., 56.)

Synthesis in the Aromatic Group.—W. Körner.—
1. *Synthesis of Anisic Acid.*—Analogous to the oxidation of nitrotoluol to paranitrobenzoic acid, the similarly constituted cresolinethylic ether



may be oxidised to methylparoxybenzoic acid, i.e., anisic acid. The author prepares cresol by boiling sulphate of diazobenzol, derived from toluidine, with water; and the methylic ether of cresol by treating cresol-potassium with methylic iodide and methylic alcohol. The ether is oxidised to anisic acid by means of potassic dichromate and dilute sulphuric acid. 2. *Synthesis of Methoxybenzoic Acid.*—This acid has been obtained by the simultaneous action of sodium and carbonic dioxide upon the methylic ether of mono bromphenol, and its identity with Graebe's and Schultzen's acid, from oxybenzoic acid, proved. As there are three mono-iodphenols known, the author considers it probable that there will be also three mono-bromphenols; so that it would be possible to derive from phenol oxybenzoic acid as well as para-oxybenzoic and salicylic acid. 3. *Synthesis of the Cresol belonging to Oxybenzoic Acid.*—On treating a mixture of methylic ether of monobromphenol with methylic iodide and anhydrous ethylic ether a reaction takes place, during which principally anisol and the methylic ether of a new cresol is formed. This ether boils at 175° C.; potassic dichromate oxydises it to methoxybenzoic acid; iodhydric acid liberates the new cresol. 4. *Mono-iodtoluol and Para-iodbenzoic Acid.*—The author prepares monoiidotoluol by treating sulphate of diazotoluol with iodhydric acid, washing the product with an aqueous solution of potassic hydrate, and distilling. It crystallises like naphthalene, fuses at 35° C., and boils without decomposition, at 211.5° . A mixture of potassic dichromate and diluted sulphuric acid converts it readily into a new acid, paraiodbenzoic acid, which is isomeric with iodbenzoic acid. The acid, when pure, crystallises well, is almost insoluble in boiling water, readily soluble in boiling alcohol. It begins to sublimate at 230° , but does not fuse at 250° .—(*Bull. d. l'Acad. Belg.*, 1867; *Just.* 1868, 54.)

New Synthesis of Iæthionic Acid.—E. Erlenmeyer and Darmstädter.—The sodic salt of this acid is readily formed by heating oxide of ethylene with a solution of sodic disulphite, in a sealed tube up to 100° C. The following is the reaction which takes place:—



—(*Zeitschr. Ch.*, N.F., iv., 342.)

Investigations on Alcoholic Fermentation.—T. Oser.—The author found amongst the products of fermentation of cane sugar and yeast, an alkaloid to which he gives the formula $\text{C}_{12}\text{H}_{20}\text{N}_4$. The chlorhydrate of this base, as obtained by evaporation in vacuo, appears as a white mass of a leafy structure, is very hygroscopic, and has a powerfully bitter taste. The base does not pre-exist in yeast, but is formed during the fermentation; from this it follows that it will be contained in all liquids having undergone alcoholic fermentation, as in wine, beer, &c.—(*Akad. z. Wien*, 1867, 209.)

NOTICES OF BOOKS.

A Dictionary of Chemistry and the Allied Branches of other Sciences. Founded on that of the late Dr. Ure. By HENRY WATTS, B.A., F.R.S., F.C.S., Editor of "The Journal of the Chemical Society," assisted by Eminent Contributors. In Five Volumes. London: 1868. Longmans, Green, and Co.

THE greatest work which England has ever produced on chemistry, one of the greatest indeed which she has produced upon any scientific subject, is finished at last, and we are able to congratulate Mr. Watts most sincerely upon its completion. The first number was issued more than five years ago, and though some slight delays have latterly occurred, the publication has been carried on with most commendable regularity. The general confidence in the learning and energy of the editor, which his previous labours had inspired, has been justified in the fullest manner, and every chemist will be proud to acknowledge the debt of gratitude which he owes to him. Very few, even among the few who were fitted for such a task, would have cared to undertake it, and no one who had undertaken it could possibly have executed it more ably or thoroughly.

The dictionary is said to be "founded on that of the late Dr. Ure." The first edition of the latter work was published in 1820, and was professedly based on the previous dictionary of Nicholson, which first saw the light in 1795, so that the new comer can boast of a very respectable pedigree. It is not a little curious to compare the three works with one another, and to mark the gigantic growth which the science made between each. The task of the editor has grown in a like proportion, and it is appalling to contemplate what it is likely to be when some chemist of the future founds a new dictionary of chemistry on that of Mr. Watts.

There is, of course, very little to say about the arrangement of the book. The alphabetical order is strictly preserved, and the editor has, we think, wisely distributed the subject as much as possible under different headings. Thus we find in separate articles,—Nitrogen; Nitrogen, chloride of; Nitrogen, detection and estimation of, &c. Difficulties occur, of course, as they would in any system, but they are lessened as much as possible by cross-references, and by the care which has generally been taken to mention each substance in as many places as it has names. The few obscurities which occur are due to the accidental neglect of this practice, and even these generally disappear when the reader has become familiar with the method of the book. Sulphuretted hydrogen may be cited as an instance of such a difficulty. This compound is not included in the elaborate monograph on the sulphur-compounds, and it cannot be found as "sulphuretted hydrogen," "hydrosulphuric acid," or "sulphydric acid." A student unfamiliar with the system adopted might hunt for some time before he thought of looking for "Hydrogen, sulphide of," under which heading the substance is described.

The subjects treated of may be roughly divided into the following classes:—

- I. Pure chemistry, which might be subdivided into theoretical, methodological, descriptive and analytical.
- II. Applied chemistry, including the applications of the science to animal and vegetable physiology, geology and mineralogy, metallurgy and technology.
- III. Physics and physico-chemistry.

The range it will be seen is very extensive, and though the volumes contain more than 5000 closely printed pages, it is marvellous that room has been found for so vast a number of facts and detailed descriptions as we find collected in them. Nothing but the most careful condensation and the most rigorous exclusion of all irrelevant matter, could have made it possible. The writers have obviously held it to be their first duty to present in each paper the utmost possible amount of fact, and to sacrifice almost every-

thing, except accuracy and clearness, in order to attain this end. This desire is most evident in Mr. Watts's articles, in which condensation is carried so far as sometimes to interfere slightly with the unity and intelligibility of the paper, and to render it somewhat unnecessarily dry. But the gain to the book, as a work of reference, which the system has produced, is so unmistakable that it would be ungracious to cavil at the disadvantages which are inseparable from it.

There is, of course, one broad and grave imperfection to be observed in the dictionary which no care or skill could have avoided; science will not stand still, even to oblige an editor, and while he is concentrating his energies on vol. ii., vol. i. will fall a little behind. This difficulty is greatest in books which are brought out in parts, and attempts to obviate it by *addenda* tacked to the end of the volumes are seldom more than partially successful. In all such books the later volumes must have an advantage, and the reader must be content to suffer some loss if the initial of the word he wants stands high up in the alphabet. We remarked in noticing the first volume that "Weights atomic" would probably have been in some respects a different article from "Atomic Weights," and in looking over the last two numbers every chemist will rejoice that "Water Analysis" did not form a portion of the article on analysis. Professor Masson once remarked that the only way to turn out a perfect encyclopedia would be for the rest of Europe to unite, subjugate the German people, and then, having supplied them with unlimited beer and tobacco, were to keep their captives hard at work until the task was accomplished. Some such simple and convenient arrangement would no doubt yield us a synopsis of chemical science which should be complete up to a certain date, but, pending its adoption, it is open to us to hope that a few of its advantages may be secured to us in a cheaper and more orthodox fashion. In a word, may we not hope that Mr. Watts will publish a supplementary volume? To carry the great work on a little farther and make it represent chemistry accurately down to a certain definite point, say to the 30th June, 1868, would surely be no very immense labour for Mr. Watts's learning and industry, and it can scarcely be doubted that such an addition to the dictionary would turn out as remunerative as it certainly would be valuable. And we will not deny that an ulterior hope lurks behind this primary one. It is high time that we had an English "Jahresbericht," a quarterly or half-yearly report of the progress of Chemical Science, which should be as full and accurate as the great German work, and a little more punctual in its appearance. It is true that the experiment was tried twenty years ago and failed, but then, as the Master of the Mint observed at one of the meetings of the Cavendish Society, the number of chemical readers now is very different from what it was then. And as soon as England and America abandon their present miserable system of mutual pilfering and agree upon an international copyright act, a large additional market for such a work will be thrown open on the other side of the Atlantic. The completion of "Watts's Dictionary," by a supplementary volume and general index, would form a grand basis for the commencement of a journal of the kind, and successive editions of the dictionary might then present the scientific public periodically with a digest of the recent acquisitions which the science had gained. Mr. Watts's most valuable habit of quoting the original memoirs with chapter and verse upon every occasion, renders his book particularly suitable to be the starting point of such a series.

The following may be cited as good examples of the theoretical and methodological articles of the book:—"Acids," "Classification," "Formulae, Rational," "Nomenclature," "Notation," and "Salt," by Professor Foster; "Atomic weights," "Equivalents," and "Metals, atomic weights and classification of," by Professor Odling; "Metals and Metalloids," by Dr. Paul; "Organo-metallic bodies," by Professor Frank-

land; "Isomerism" and "Secondary alcohols," by Professor Wanklyn; and "Alcohols," "Aldehyds," (rather short and imperfect, with an obvious error as to oxide of ethylene, but then the word begins with A), "Atomic volume," "Chemical affinity," "Hydrocarbons" (likewise too short), "Isomorphism," "Substitution," and "Types," with many others, by Mr. Watts. It will be seen that a considerable proportion of this part of the work has fallen upon Professor Foster. The editor's choice has been a wise one, for the articles are written with singular clearness and simplicity, and with careful and thoughtful study. "Nomenclature" is a good sample. It begins in the following words:—

"Chemical Nomenclature is the spoken language of chemistry, as the Symbolic Notation is the written language of the science. Being thus at once the product and the instrument of thought upon Chemical subjects, it has necessarily, at every period in the history of the science, reflected the general intellectual character of the time, as well as the stage of development which chemistry had reached."

Accordingly the modern system is introduced by a learned and highly interesting historical sketch, in which the successive changes which chemical names have undergone, from the Sol and Luna of the early writers down to the marvellously flexible system of the present day, are described so well as to make the story quite amusing. We commend the introduction of these historical notices, and are glad to find that Professor Foster has adopted the practice in several articles, and that several other writers, among whom we may mention Dr. Paul, whose article—"Gas"—is entirely occupied with the history of the subject, have done the same.

We should have felt it necessary to allude at some length to Dr. Odling's contributions to the work, if we had not done so on a previous occasion (vol. xiii., pp. 31-57). Of course they are very good, and the exposition and frank adoption of the Cannizzarian system in the last of them are admirable in every sense. Professor Wanklyn does not appear to have contributed very much, but what he has done is good and well written. Probably if he had to write the article on "Isomerism" now he would find more to say, but, having wisely abstained from mere speculation, he would not find much that required alteration. The article was published in 1864, while that on "Secondary Alcohols" did not appear till 1866. Curiously enough these same secondary alcohols, the study of which had hardly commenced when the former article was written, had in the meantime thrown a most important light on the nature of Isomerism. In the latter article the author has made the mistake of not giving sufficient references. He should moreover have explained the nomenclature which Kolbe and Butlerow employ. He does not even mention it, and only alludes to trimethylcarbinol under the much less significant name of "Abnormal butylic alcohol." And lastly, for the sake of those who are not familiar with the subject, he should have given the names, and not merely the formulae of the compounds concerned in the genesis of the alcohols, especially as the formulae are of a different kind from those usually employed in the book. Professor Frankland's article on the "Organo-metallic bodies," calls for no remark, it being simply a condensed and corrected reproduction of his well-known lecture delivered to the Chemical Society, June 7, 1860,—a lecture which was published in the Society's Journal, and which is familiar to every chemist in England.

Turning now to the descriptive articles, which constitute the great bulk of the book, we find very much to admire and very little to find fault with—so little, indeed, that we do not care to find fault at all. It is indeed unnecessary to say much about them, for nearly all our readers know the book and have been using it constantly for years, and those who have not taken in the monthly parts will soon find themselves compelled to buy the complete work. Nearly the whole of this portion of the work is from the pen of Mr. Watts; but he has received valuable assist-

ance in a few important subjects, of which the following will serve as samples:—Amyl and its associates, by Professor Guthrie; "Atmosphere," by Professor Roscoe; the Ammonia and Benzoic series, by the late Mr. Conington; Bismuth, and the Butylic series, by Dr. Atkinson; "the Hexyl group," by Professor Wanklyn; "Naphthaline," by Mr. Greville Williams; and the lactic series, by Professor Foster. The late Mr. Long was also a useful contributor, and in illustration of his style we may refer to the articles "Blood," "Casein," "Fibrin," "Milk," "Gelatin," and "Garnet."

The following are some of the chief articles on analytical chemistry. They are all excellent, and so nearly equal, that it would be unfair to single out any one of them for praise:—"Analysis, inorganic," by Mr. Conington, who wisely left quantitative analysis to separate articles; "Analysis, (organic)," a full and lucid treatise, by Mr. Watts; "Analysis (volumetric) of liquids and solids," (Mr. Dittmar); "Analysis (volumetric) of gases," Dr. Russell; "Spectral analysis," (Professor Roscoe). Our limits make it impossible for us to do more than give the titles of these papers.

Another large portion of the book is occupied with the various branches of Applied Chemistry. In spite of the immense interest and importance of these subjects, we find with regret that we can do little more than give the names of some of the most important articles. The reviewer's taste, in dealing with a book of this magnitude, is indeed, a somewhat unsatisfactory one. The space at his command is hopelessly inadequate for anything like a complete examination of the work, and, with all his efforts to distribute his notice fairly, he is sure to be haunted by an uneasy feeling that he has given too much to some and too little to others.

Some of the best articles in Physiological Chemistry are by Dr. Michael Foster, whose name does not appear until the middle of the third volume. "Nutrition," "Respiration," "Muscular tissue," "Nervous tissue," and "Pancreatic juice," are good examples. It is somewhat unfortunate for physiologists that the masterly essay upon nutrition was written just before the publication of works so important as Ranke's "Essay on Tetanus," Fick and Wislicenus's memoir on the "Origin of Muscular Power," and Frankland's determination of the "Calorific Value of Food and Urea." But the author has reasoned too accurately to fall into the error of Liebig and others, and his paper is therefore even now rather incomplete than incorrect. Akin to these subjects are the various articles upon vegetable physiology, agriculture, &c., which are scattered through the book:—"Nutrition of Plants," by Dr. M. Foster; a very good one on "Manure," by Dr. Paul; and another on "Soils," by Mr. Watts, are among the most important.

Of the Metallurgical articles which we meet with, the following are the chief:—"Copper" (very clearly and completely) and "Zinc," by Mr. Watts; "Iron" and "Silver" by Dr. Paul; "Lead," by the late Dr. Richardson (nearly 70 pages long: excellent, but too technical, we think, for a book on chemistry); "Tin," by Mr. Field; and "Gold Assay," by Mr. Jevons. Technology is but slightly represented in the book, the editor having wisely left it to the elaborate special treatises upon the subject which now exist. The recent new edition of "Ure's Dictionary of Arts," and the valuable work founded on "Knapp's Technology," of Richardson and Watts, leave little to desire in this respect. Many of the articles in the work before us are, however, concerned more with technology than pure chemistry; and Mr. Watts's papers on "Soap," "Dyeing," "Alcoholometry," &c.; Dr. Richardson's "Potassium salts, manufacture of"; Mr. A. W. Wills's "Coal" and "Coal-gas"; and Dr. Paul's "Fuel," "Paraffin," "Peat," and "Petroleum," will be sufficient to show the manufacturer how large an interest he has in the book.

It only remains to us now to notice, in few words, the very important and copious articles which have been

allotted to Physics. The following list comprises the most important of them, arranged according to their authorship:—"Crystallography," "Diffusion," (distributed through various articles), "Electricity," "Light," and "Magnetism," by Mr. Watts; "Heat," and "Radiation and Conduction of heat," by Professor Foster; "Gas, absorption of," and "Light, chemical action of," by Professor Roscoe; "Specific Gravity," by Mr. Greville Williams; and "Balance," "Clouds," "Barometer," and "Thermometer," by Mr. Jevons. Mr. Watts's contributions in this department are among the best he has written, and are decidedly superior to his article on theoretical chemistry. He seldom expresses an opinion of his own, but contents himself with collecting and arranging with immense skill all that is trustworthy upon the subject he is treating. Now and then a few words of acute commentary occur, when they are absolutely necessary, but he evidently tries to avoid the necessity. This is just the way to give the greatest value to a book of this kind. Original essays are of course of primary importance and utility, but a dictionary is not the place for them. The reader of a dictionary generally wants to find, not what some single writer has said upon a subject, but the aggregate of facts, theories, and opinions which have accumulated up to a certain date, and he is sure to bless the editor who has been self-denying enough to sink his own opinions, and to devote his whole labour to the elucidation of the labours of others. It is, perhaps, not too much to say that no man in England is so fit for the labour of a scientific editor as he to whom we owe our dictionary. Wishing to avoid hyperbolic praise, it is indeed difficult to speak calmly of the service which Mr. Watts has rendered to science. Some four-fifths of the entire work are from his pen, and he is therefore entitled to be considered as the author and not the mere editor of it. His learning is universal, and not only carries him through every corner and byway of pure chemistry, but also makes him at home in every one of its branches. When we consider that he has contributed important articles in each section of chemical science, that he has written with nearly equal learning upon digestion and magnetism, atomic volumes and soap, and that he has besides had the labour of compiling nearly all the smaller articles, and of selecting and arranging the whole book, we feel justified in speaking with a certain enthusiasm of the chemist who has so well carried out so great a work.

We have purposely said very little of the few faults and omissions which we have found in the Dictionary. Of course there are some, but they are few and in most cases trifling; and as the utmost that we could attempt would be to pick out an instance here and there, as, moreover a new edition cannot reasonably be looked for for some time, we see no good that would be served by the scrutiny. And it is far pleasanter, in praising a good book, to praise it cordially, without hypercriticism or carping reservations. Every chemist who understands the English language will, we feel quite certain, join heartily in our praise.

Swedenborg as a Man of Science.*

THE Rev. Charles Kingsley Professor of Modern History in the University of Cambridge, asserts in his *Miscellanies*,† that—

"The world only knows Swedenborg as a dreaming false prophet, forgetting that if even he was that, he was also a sound and severe scientific labourer to whom our modern physical science is most deeply indebted."

Are there any grounds for this assertion? Is our modern physical science most deeply indebted to Swedenborg? If so, in what particulars?

From his youth, Swedenborg took a lively interest in

* *Emanuel Swedenborg: His Life and Writings.* By William White. Second edition, in one volume. London, 1868.

† Review of Vaughan's *Hours with the Mystics.*

general science, and his mind teemed with speculations, theoretical and practical. He was offered the Professorship of Mathematics at Upsala, which he declined. "It is the fatality of mathematicians," he wrote, "to abide in theory. I have often thought it would be a capital thing, if to each ten mathematicians one good practical man were added to lead them to market; he would be of more use and mark than all the ten." Charles XII. employed him in military engineering, and in 1716 appointed him Assessor in the College of Mines.

Up to 1722 he was an industrious pamphleteer, writing on docks, sluices, and salt works, on the manufacture of tin-plate, on improved stoves, on decimal measures and coinage, on algebra, on finding the longitude at sea by the moon, on the decrease of the rapidity of the earth's rotation, on the tides of the ancient world, on chemistry, geology, &c., &c. Throughout all his discussions he displays a sagacious intellect, never whimsical, bold, yet true to common sense. For instance, reasoning on chemistry, he asks, "What is there in nature which is not geometrical? What is the variety of experiments in chemistry, but a variety of position, figure, weight and motion in particles?" and then goes on to assert that chemical combinations can be nothing but the re-arrangement of variously-shaped atoms. The experiments wherewith he illustrated his doctrine are, in our light, crude and absurd, but the conjecture was one with which Dalton would have sympathised.

For twelve years from 1722 he printed nothing, but in 1734 amply accounted for his silence by the publication of three noble folios entitled *Opera Philosophica et Mineralia*. The second and third of these are practical and technical, giving an account of iron and copper mining, and the processes of manufacture in use last century. His disclosure of trade secrets was resented, but he argued, "Why should facts be withheld from this enlightened age? Whatever is worth knowing should by all means be brought into the great and common market of the world. Unless this be done, we can neither grow wiser nor happier with time." These volumes have an abiding value as records of methods in use last century: as Dr Percy observes, "The metallurgical works of this remarkable man seem to be very imperfectly known—at least they are rarely if ever quoted; and yet none in my judgment are more worthy of the attention of those interested in the history of metallurgy."*

The first volume, entitled, *Principia, or the first principles of natural things, being new attempts towards a philosophical explanation of the Elementary World*, constitutes Swedenborg's most characteristic claim to attention. An English translation in two volumes was published by the Rev. Augustus Clissold in 1845-46.

The *Principia* is an endeavour to explain the origin and method of creation. Nature is asserted to start from "points of pure and total motion produced immediately from the Infinite," which motion is said to be vortical.

From the congress and compression of points are formed what he calls first finites, revolving on their axes under the impulsion of their constituents; in this respect perfectly resembling the earth, although in comparison with the least things visible they are quite inappreciable.

Out of the first finites by still further compression are formed second finites, which are said to constitute the first element, filling the whole space of the stellar heavens and composing the solar vortex.

From second finites by yet further compression are produced third finites, which constitute the magnetic element.

Again third finites are compressed into fourth finites, or the third element called ether.

Ether under further compression becomes air, and air compressed becomes water, and water under similar treatment yields salt and all minerals.

Such, according to Swedenborg, is the derivation and procession of the elements. Derived from the original

point is a ceaseless motion, whereby all subsidiary matter is maintained in vortical whirl.

For the confirmation of the theory he turned to the phenomena of magnetism. Professor Musschenbroek, of Utrecht, had published in 1729 *Physicæ Experimentales et Geometricæ Dissertationes* abounding in magnetic observations. These Swedenborg freely transferred to his pages, and applied them in proof of vortical motion. Musschenbroek held that magnetic attractions and repulsions observed no certain laws: Swedenborg on the contrary maintained that nowhere was order more demonstrable.

A cardinal principle with Swedenborg was the uniformity of creation—that size makes no difference; that the method of Nature is everywhere the same; that the energy that shapes a dew-drop shapes a world; that the mechanism of the trunk of an elephant and a fly is the same. This truth he considers of inestimable value, because by analogies drawn from the seen we may predicate the unseen, and deal with it as though it lay under our eyes.

Consistently, then, he applies his doctrine of atomic to cosmic creation. Suns are sires of systems; suns therefore consist of points of motion produced from the Infinite. The condensation of these points results in ether, which thrown off from the sun, breaks by attenuation, and collapses in planets; which spheres of ether by slow degrees condense to air, to water, to salt, to *terra firma*.

So pleased was Swedenborg with the conception that he expanded it in a romance entitled the *Worship and Love of God*, wherein he pursues the story of creation through flora and fauna to Adam and Eve.

His next undertaking was a search for the human soul in the body. He determined to allow himself no rest until he had discovered and demonstrated its existence, and for this purpose devoted several years to the study of anatomy. In 1741 he published the *Economy of the Animal Kingdom*, and in 1745 the *Animal Kingdom*, which he left unfinished. These works are simply physiological studies—a grouping and discussion of the facts of the anatomists as preliminary to his quest.

About 1744, in his 56th year, occurred the great mental convulsion which converted him to spiritualism—to a professed familiarity of angels and devils. With that phase of his character we do not meddle. Our concern is to appraise his scientific import.

First it is to be remarked, that his books do not appear to have had any popularity. There is no evidence of their influence on his generation. He dropped them himself, considering he had outgrown them, and some of his acquaintances in later years scarcely knew of their existence. They were revived in English by the Swedenborg Association in 1845-47, but only to lapse once more into oblivion.

What then are Swedenborg's claims as a man of science? We should answer, in any eminent sense, none whatever. He was well informed; he was abreast of the science of his time, but did nothing to extend it. He was a theorist, and rarely, if ever, an experimentalist. It is said Buffon possessed a copy of his *Principia*, and as Laplace owns that Buffon first suggested to him the derivation of earths from suns, it is presumed Buffon derived the idea from Swedenborg. Suppose he did: at the best it is a small matter. The unity of creation with the probability that all things proceed from one thing, is a notion old as philosophy. Again it is urged, Faraday conjectured that all matter might finally be reduced to forms of energy, and that is Swedenborg's notion. True; but Faraday's merit lay not in the conjecture, but in the original and ingenious experiments wherewith he supplied evidence for the conjecture. Again, in one place Swedenborg speaks of seven planets when only six were known; therefore, it has been asserted, he predicted the existence of Uranus. So likewise did Sterne when he made Dr. Slope ask "Are there not seven wonders of the world? seven days of creation? seven planets? seven plagues?" The mystic value assigned to seven was the origin of the planetary and other numbers.

* Metallurgy by John Percy, M.D., part I., p. 439.

Were Swedenborg's theories even more suggestive, we should dismiss such claims as happy guesses among numerous errors. Indeed, how is it possible for any mind of sagacity and experience like his to speculate extensively without occasionally drawing near to truth? but the merit of the theoriser is of small account inasmuch as he never knows when he is near and when remote from truth. Students of bygone scientific philosophy are continually surprised with hints which modern research has converted into verities. As Sir Henry Holland, writing of Dalton and the Atomic Theory, observes, "Certain questions as to priority of discovery meet us here, even at the outset. This, it is well known, has happened in almost every similar case. In the history of the greatest discoveries (even that of universal gravitation) we find the record of men who have seen the light before them, have approached near to it, but have missed the sole path by which the lamp could be seized." We do not depreciate theory: conjecture must always precede intelligent discovery; but we must reserve the honours of science for those who reduce conjecture to truth by the evidence of experiment.

A Treatise on the Metallurgy of Iron, by H. BAUERMAN, F.G.S., &c.—London: Virtue & Co.

In the preface the author states his book to have been written with the view of supplying a work available for the technical education of those to whom an accurate knowledge of the physical properties of ores, and of the latest and most approved means of reducing them to the condition required by the manufacturer, has become an imperative necessity, in order to enable them fully to meet foreign competition.

The two great and inseparable questions—technical education and foreign competition—have lately been ventilated in public papers and speeches, as well as demonstrated *ad oculos* by the different international exhibitions of arts and industry, and we feel ourselves justified in advocating even further advances in technical education than have yet been made. The inferiority of our technical education, as shown by comparison with that in foreign countries, may be attributed to the insufficiency of our technical literature, and for this reason every literary contribution having a tendency to supply this deficiency should be hailed with pleasure and satisfaction.

Mr. Bauerman's treatise gives a fair view of the theory and practice of iron manufacture in all its branches, duly including the two great improvements of recent days, namely, the Bessemer process, and Siemens's regenerative gas furnace, which will doubtless form a new epoch in iron manufacture. All the different branches of iron manufacture have been discriminately treated of, as far as the limited compass of the compendium would allow; we only regret that the number of illustrations is rather limited. Upon the whole, we are of opinion that Bauerman's work is a valuable addition to the library of English educational scientific works.

On Aniline and its Derivatives: a Treatise upon the Manufacture of Aniline and Aniline Colours. By M. REIMANN, P.D., L.A.M. To which is added, in an appendix, "The Report on the Colouring Matters derived from Coal Tar, shown at the French Exhibition, 1867." By Dr. A. W. HOFMANN, F.R.S., MM. G. DE LAIRE and Ch. GIRARD. The whole revised and edited by WILLIAM CROOKES, F.R.S., &c. London: Longmans, Green, and Co. 1868. Pp. 164.

The German treatise of Dr. Reimann possesses nearly every merit which can distinguish a book intended for manufacturers. It is very lucid and simple, it presupposes nothing but an elementary knowledge of chemistry, and it is so well arranged that all the information it contains is accessible in a minute. It is eminently practical, and yet contains enough theory to render the fact comprehensible, and to give the memory a grasp upon it. The French Exhibition report is, of course, super-excellent, and affords a curiously apposite

completion to Dr. Reimann's work. Dr. Hofmann's luminous and vivacious style, so well known to all English chemists, is apparent throughout, and gives a kind of sparkle even to the recital of dry scientific facts. He has the somewhat rare power of enlivening every subject which he touches, without sacrificing scientific precision, and without ever verging upon flippancy.

It is, for obvious reasons, impossible for us to comment upon the manner in which the English editor of these two good books has done his work. Many of his readers will be abundantly able to sit in judgment upon him, and he will be perfectly contented to accept their award of praise or blame. Our duty will be sufficiently discharged if we give a brief sketch of the contents of the volume, together with a few extracts by way of example.

Dr. Reimann's treatise is divided into ten chapters, in which the various products are discussed as nearly as possible in the order of manufacture. Chapter I. is devoted to Benzol, its composition, mode of preparation, &c. The author has said very little of the process of distillation, because, as he remarks, it is seldom performed by the aniline manufacturer. Nitrobenzol is considered in chapter ii., and its manufacture is illustrated by drawings of the apparatus employed. Chapter iii. introduces the reader to aniline. Many methods of preparing the base are mentioned; and Béchamp's well-known process is described in detail, and illustrated by a drawing. Among the less generally known methods, that of Kremer may be mentioned:—

"In 1863, M. Kremer found that aniline might be obtained by heating nitrobenzol with water and zinc powder as obtained in zinc manufactories, oxide of zinc being formed. From 100 parts of nitrobenzol he obtained from 63 to 65 parts of aniline. Zinc powder being at the present time cheap, this method may possibly be economically employed."—(P. 17.)

The author distinguishes the aniline oil from light benzols as *Kuphaniline*, and that from heavy benzols as *Baraniline*; and he gives the following very simple directions for ascertaining their relative proportions roughly in any given sample of aniline oil:—

"I put 100 cubic centimetres of kuphaniline in a glass retort, which I placed in a bath of oil or paraffin heated by a lamp. The tube of the retort was joined to a Liebig's condenser, and at the extremity of the condensing tube I placed as receiver a graduated cylinder by which the number of cubic centimetres of distillate could be observed. Of course the condensing apparatus was supplied with cold water. Having placed a thermometer in the neck of the retort, I began to heat.

"At first some drops of liquid, consisting of benzol, a little aniline, and water, distilled, so that when the mercury in the thermometer had risen to 180° C., 8½ cubic centimetres had distilled, of which 2½ were water, and the rest a mixture of benzol with a little aniline and odourine. By continuing the heating of the oil distilled in large quantities, so that when the thermometer had risen to 185°, 54 cubic centimetres had distilled between 180° and 185°. Up to 190°, 34 cubic centimetres distilled, so that the remaining oil was only 3½ cubic centimetres. Of course another sample of kuphaniline oil will not yield precisely the same numbers, but they will be at all events similar to those above mentioned.

"When baraniline is heated in the same manner up to 190°, from 100 cubic centimetres of the oil 3½ will be distilled, of which two are water and the rest aniline oil, with a little undecomposed benzol. Between 190° and 195°, 8 cubic centimetres distil; then up to 200°, 18; from 200° to 205°, 39; from 205° to 210°, 19; from 210° to 215°, 7 cubic centimetres; 5½ remaining in the retort.

"Now, if we compare the quantities of both oils distilled at different temperatures, we shall find a great difference; so that by distilling in the above manner it is absolutely impossible to mistake a kuphaniline for a baraniline, and vice versa."—(P. 27.)

By referring to a table given on page 30, the proportions of the two oils can be inferred. Chapter iv. deals with Magenta. It is very long, and, although one of the most important in the book, affords few passages suitable for quotation. To some readers the following may be new:—

"Every aniline salt yields magenta when heated with pure aniline to 150° C. Sulphate of aniline, heated to 200° C., turns to a violet black, and then yields, when treated with water, a solution of magenta. In a similar manner, hydrochlorate of aniline is transformed into a red colour, by heating it dry, and mixed with sand or fluor spar, for three hours to a temperature of 180° C.

"To produce magenta in this manner on a large scale, according to M. Delvaux, one equivalent of hydrochlorate of aniline is mixed with tenfold its weight of sand, and one equivalent of aniline. After agitation, the mixture is heated for fifteen hours, at from 110° to 120° C., or five to six hours to 150°, or two to three hours to 180°. The mass so treated is then put into boiling water, by which a large quantity of the red colour is dissolved out."—(P. 47.)

The chapter concludes with an account of leukaniline and chrysaniline.

Chapter v. brings us to aniline blue and violet. The methods of Perkin and Church, Kœchlin, Béchamp, Crossley, Beales and Kirkman, Phillips, &c., are described, and afterwards the much more important processes in which the colour is obtained by the alteration of salts of rosaniline. The following remarks upon Hofmann's violet will be found interesting:—

"The iodide of methyl, amyl, propyl, or capryl, may be used instead of the iodide of ethyl in the above process, and instead of iodine, bromine may be used. The new violet has a richer colour, and its shades are brighter, than those of the common aniline violet. It was at first manufactured by the firm of Simpson, Maule, and Nicholson, to whom the patentee sold his privilege. Soon after, a German manufacturing chemist, Mr. Rudolph Knosp, of Stuttgart, began to make this violet, and it is now made by every continental manufacturing chemist. When dry it has a splendid metallic lustre. It is sold also under the name of *primula*.

"In the manufacture of Hofmann's violet on the large scale, the proportion of iodide of ethyl is considerably diminished, in order to save the expense of the iodine. According to my own researches, 12 parts of iodide of ethyl are sufficient to transform 16 parts of magenta into Hofmann's violet.

"It is remarkable that German chemists did not at first succeed in producing the blue shades of violet, which are so easily obtained in England, and the bluish shades could only be produced by using iodide of methyl instead of iodide of ethyl. This interesting point is easily explained, for the methyl substitute formed by using iodide of methyl is of an intensely blue colour. It was not necessary for English chemists to make a direct use of this methyl compound, since at the exorbitant price of alcohol the much cheaper methyl-alcohol was always used in England to dissolve the magenta and to render it capable of transformation."—(P. 71.)

The four next chapters are occupied respectively with green, black, yellow, and brown dyes, and would yield many quotations if we could spare room for them. Lastly, chapter x. gives some directions for the determination of the tinctorial power and intensity of the aniline colours, together with a short account of Pohl's method of distinguishing aniline colours from one another, and from similar colours when on the textile fabric, by means of strong and dilute hydrochloric acid.

The Exhibition Report is crowded with interesting matter from beginning to end, and our only difficulty is to know where to choose our quotations. We select the following passages almost at random:—

"In France three millions of tons of coal are carbonised annually to supply coke for metallurgical purposes. When

the process of MM. Pauwels and Knab is more generally adopted there will be collected from this 125 or 130 millions of kilogrammes of tar, which would yield 2 or 3 millions of kilogrammes of light hydrocarbons. It may therefore be predicted that the price of benzols will fall still more, and that consequently the cost of colouring matters derived from it will be reduced. These prices are at the present time from 70 to 80 centimes the kilogramme for benzol; in 1862 it was worth three or four francs the kilogramme. Aniline, which then cost from 12 to 18 francs, is now worth 2.25 francs, or 3.5 francs at the maximum. Crystallised hydrochlorate of rosaniline has fallen from 250 or 300 francs to 25 and 30 francs. The blue, which was formerly sold at 500 francs, is now offered at 100 francs, and inferior qualities cost only 30 or 40 francs. These figures prove in a most convincing manner the enormous progress realized by the aniline colour industry since 1862."—(P. 104.)

"Night Blue—The term night blue (*bleu lumière*) is given to a blue entirely free from violet, and which preserves its clear blue colour in artificial light. It is nothing more than a perfectly pure salt of triphenylrosaniline. To obtain it a good purified blue is taken, such as is given by the preceding process. After several washings with warm alcohol, the residue is reduced to fine powder, dissolved in boiling alcohol and the solution filtered. To the clear liquid is added ammonia, or, better still, an alcoholic solution of caustic soda; all the blue is precipitated in the state of base. When the ammoniacal or sodic alcohol solution is quite cold, the triphenylrosaniline is collected on a filter, washed once or twice with boiling water, and then treated with the necessary quantity of acid to form a salt. It will be seen that this operation is extremely simple and gives satisfactory results."—(P. 127.)

"A dyer, like all others of his craft at that time, was busily occupied experimenting with the aniline dyes. Amongst other things he tried a reaction which had been described by M. Lauth at the end of 1861, viz., that of aldehyde on a sulphuric solution of aniline red. In this reaction, a substance is produced which gives to solutions an extremely evanescent blue colour. M. Lauth had given up all idea of utilising this blue colour in practice; and M. Cherpin endeavoured to fix the same colour on silk or wool with similar want of success. His attempts, although fruitless, were incessantly renewed, exhausting his purse, but not his patience. One day, however, discouraged at the want of success attending some recent experiments on which he had founded great hopes, he was on the point of relinquishing the attempt at the conquest over this fugitive blue, when the idea struck him to confide his troubles to an old friend, a photographer. 'A trouble shared is a trouble halved,' says the proverb; Cherpin proceeded to test this saying, and experienced the reward of his perseverance and his confidence in the consolations of friendship. He found his photographic friend, and confided to him the history of all his hopes, his experiments, and his fruitless results.—'Fix the blue?' said his friend. 'Is that the only difficulty? Why it's the easiest thing in the world! Have you tried hyposulphite of soda?'—'Hyposulphite of soda? *Mon Dieu*, no! Do you think it will fix my colour?'—'Of course it will. Don't you know that hyposulphite of soda is the fixing agent *par excellence*, and that when we want to fix anything in photography, that is the substance we always employ?'

"Happy is he who possesses faith! Cherpin tried hyposulphite of soda, and his joy and admiration of the chemical knowledge of his friend may be imagined when he saw his blue colour metamorphosed into a splendid green, this time perfectly stable. It is scarcely necessary for us to add, that the mode of action of hyposulphite of soda in this case is entirely different from its photographic action, and that it would be quite impossible to predict the one by knowing the other.

"This anecdote contains a moral. It shows, in our opinion, not the result of chance,—for that is common to all the world, for where is the discovery to which chance has not

more or less contributed?—but it shows the power of the will, the power of perseverance. Chance only favours two kinds of persons; those sufficiently instructed, or endowed with talents eminent enough, to observe it, to seize it, and to profit by it; and those who, by patience, perseverance, and the power of their will, force it in time to become useful to them."—(P. 133.)

"The greatest uncertainty still exists as to the chemical constitution of aniline green. We are, however, justified in hoping that this will soon cease to be the case; aniline green is now a commercial substance, manufactured on a large scale, and is becoming more and more pure every day. After having presented to science a problem, without furnishing the data necessary for its resolution, manufacturing industry is working to fill up the gap, and everything leads us to anticipate a successful result."—(P. 136.)

A final quotation from the reporter's introduction will form an appropriate termination to our notice of this record of some of the most striking gifts of science to civilisation which the world has ever witnessed:—

"Thus, rosaniline has become the parent of a whole series of colours, and last of all of a green. The gamut of colouring matters derived from aniline is now complete; we have red, orange, yellow, green, blue, indigo, and violet.

"Are we not justified in saying that the manufacture of artificial colouring matters, in spite of the improvements of which it is yet capable, in spite of the discoveries which will yet enrich it, and scarcely ten years old, has emerged from the state of infancy, and become one of the most important industries of the age?"—(P. 100.)

What should we Drink? By J. L. DENMAN. London: Longmans, Green & Co.

The material prosperity of this country owes much more to a constant process of delegislation than to the making of new laws. From corn-law repeal down almost to the present period, most of the beneficial work of Parliament has consisted in sweeping away the grievous fiscal laws imposed by the unwisdom of our forefathers upon body and mind—upon our food, raiment, the materials of our dwellings, and the means of knowledge. For more than a century wine has been subjected to a perverse fiscal contrivance, as if for the very purpose of vitiating the national taste, fostering gout and rheumatism, and in other ways spoiling human tissue. That for a hundred years this country should remain content to drink only coarse factitious wines, called port and sherry, will, we doubt not, prove a marvel to the next generation. Thanks to Mr. Gladstone, we may now, if we will, drink wine pure and good, and cheap; but our past blind fiscal arrangements regarding wine and the trading interests therewith interwoven, have enveloped the subject in a cloud of ignorance and prejudice, which only time and free discussion can disperse. To Mr. Denman the public ought to be much obliged for his vigorous onslaught upon the brandied, elder-berried, unwholesome wines of Spain and Portugal, and for his ruthless exposure of the nefarious system of "applied chemistry" to the manufacture of so-called wines in force at Certe and Hamburgh. To Mr. Denman we owe the first introduction to the English market of the excellent Hungarian wines; and every one knows that to him we are indebted for naturalizing Greek wines in England. If we cannot go quite so far as Mr. Denman, whose interest as a wine merchant may be supposed unconsciously to stimulate somewhat his enthusiastic advocacy, we are quite prepared to say that he has conferred no inconsiderable boon upon the community by the enterprise and judgment which led to the introduction of Greek wines into this country. Having divested himself of prejudice against novel wines, let anyone, whose taste has got beyond the low stage of port and sherry, try some of the

drier sort from Mr. Denman's list, and if they do not commend themselves to his palate by all the characteristics which should distinguish natural wine—homogeneity, delicate sub-roughness, body, bouquet, and the power of conferring an *ab imo pectore* sense of well-being—the failure, we take it, ought not to be attributed to the wines. For the "sick and the sorry" the writer hereof—a physician—can testify to their nerve-nourishing, comforting, and invigorating virtues. We have referred to these wines as "novel," but—shade of Bacchus!—Greece is the classic soil of the vine. She gave to the wine-growing countries of Europe the cuttings whence sprung their wide-spreading vineyards. Long ere the vine clad the slopes of the Rhine, the banks of the Garonne, or covered the Côte d'Or, it flourished on the volcanic soil of Greece. Free now from Turkish oppression, the alert commercial spirit of the Greeks may yet furnish us with unrivalled wine, such as won lavish praises from their antique poets, and so, in one respect at least, Greece may once again "teach the nations how to live."

CORRESPONDENCE.

Death from Carbolic Acid.

To the Editor of the CHEMICAL NEWS.

SIR,—Will you kindly allow us sufficient space to say that the jury's verdict on the cause of Mr. Berger's death is evidently in error where it states that the *inhalation* of carbolic acid produced the lamentable result.

Our workmen frequently *inhale* carbolic acid in very large quantities during the process of its manufacture, and we have not known a single instance of ill-effect therefrom; and we can also state that it has been most extensively used in *proper inhalers* for several years in the cure of consumption, throat and chest diseases.

To us it is very evident that Mr. Berger died from the effects of accidentally *drinking* carbolic acid, and had any one been at hand to administer promptly a mixture of sweet oil and castor oil, his life might possibly have been saved.—We are, &c.,

F. C. CALVERT & Co.

Manchester.

High Chemical Formulae.

To the Editor of the CHEMICAL NEWS.

SIR,—I have to correct an error committed by me in the course of the discussion at the last meeting of the Chemical Society.

Sir B. Brodie describes in his papers the ethylic ether of one of the wax-acids, and not the acetate of a wax-alcohol. By a strange, but intelligible oversight, I had confounded the one with the other. This mistake, which is here rectified, has, as will be obvious, no influence on the main questions which were before the Society.

When I have leisure, I may possibly set to work to prepare acetate of melissyl by the process sketched out by me.—I am, &c.,

J. ALFRED WANKLYN.

London Institution, June 29, 1868.

Notes on Ozone Development during April, May, and June, 1868.

To the Editor of the CHEMICAL NEWS.

SIR,—I beg to forward the enclosed "Notes on Ozone Development" during the past three months:—

Large Amounts.—April 2nd (aft.), 8th (morn.), 18th (aft.), 19th, 22nd (morn.), 23rd (morn.), 24th, 25th (aft.), 28th; May 1st (morn.), 5th (morn.), 10th (aft.), 11th, 17th (aft.), 22nd, 23rd, 24th (aft.), 29th (morn.), 31st; June 1st (aft.), 4th,

* Dr. Quesneville informs us that since the publication of this report MM. Girard and de Laire have obtained aniline green in the crystallised state, giving the most brilliant results in dyeing."

22nd. *Small Amounts*—April 13th (aft.), 15th (morn.), 16th; June 5th (morn.), 12th (morn.), 19th (aft.), 26th (morn.), 28th (morn.) *No Ozone was found*—April 9th (aft.), 10th (aft.), 11th, 12th, 17th (morn.), 20th (morn.); June 29th (morn.).

The greatest change in ozone development between any two consecutive days occurred between the 19th and 20th of April. Considerable changes also occurred between the 8th and 9th of April, the 4th and 5th of June, and the 18th and 19th of June.

Ozone development was extremely variable throughout the day on April 15th, 21st, 27th—30th; May 1st—5th; June 20th—22nd; and variable throughout the day on April 13th, 14th; May 24th, 25th; June 5th—8th, and 14th.—I am, &c.,

R. C. C. LIPPINCOTT, F.M.S.

Highcliff House, Eastbourne, July 3rd, 1868.

Death from Carbolic Acid.

To the Editor of the CHEMICAL NEWS.

SIR,—Allow me to add my opinion to Messrs. F. C. Calvert and Co.'s, that the jury's verdict on the cause of Mr. Berger's death is an error, and that the gentleman must have died from drinking carbolic acid, and not from inhaling it.

The only complaint that my assistants make, from constantly inhaling carbolic acid, is that of increased hunger.

I have been continually experimenting with carbolic acid for more than a year, and practising its inhalation upon myself, sometimes to intense inconvenience, and I can scarcely think it possible to cause death in that way.

It may be painful to the friends of this excellent gentleman, to be told that he must have drunk carbolic acid; yet the accuracy of this fact is important to the last degree, lest an insane prejudice should be created against the use of carbolic acid, just as its marvellous effects in consumptive cases, skin diseases, &c., are beginning to be generally known.

Neither new nor old remedial agents should be used indiscriminately. Excess can never be made the rule of life, and they who try excess must suffer.—I am, &c.,

T. A. READWIN.

108 Dorset Street, E. C.

Cornish Minerals—Woodwardite.

To the Editor of the CHEMICAL NEWS.

SIR,—As there will be no meeting of the Chemical Society for some months, will you allow me to say a few words in your columns with reference to the recent discussion on Woodwardite?

I much regret my unavoidable absence from the meeting at which my "Mineralogical notices" were read. The speakers, who appear to have criticised somewhat adversely my views as to the rank of Woodwardite as a species, do not seem to have read my original paper on that subject. In the examination of this mineral, as well as of others which I have described, every possible precaution has been taken to secure an accurate result. Really distinct specimens have been analysed, their physical characters have been minutely ascertained and described, and their modes of occurrence have been studied, as far as practicable. As I have always taken, in describing new minerals, the very obvious precautions suggested by my critics, their criticism is inappropriate.—I am, &c.,

A. H. CHURCH.

The Lizard, Cornwall, July 9th, 1868.

MISCELLANEOUS.

Chemical Society at Newcastle—We are glad to hear that, at a meeting held on Monday evening last, at the Literary and Philosophical Institution, under the presidency

of Sir William Armstrong, K.C.B., it was decided to form a "Newcastle Chemical Society." Meetings are to be held monthly from October to March. Messrs. E. J. J. Browell, R. Calvert Clapham, H. B. Brady, A. Friere Marreco, J. W. Swan, J. Pattinson, B. S. Proctor, W. H. Richardson, and Dr. Lunge, were constituted a committee to make the necessary arrangements.

Another Explosion of Nitroglycerine.—We have received accounts of a disastrous explosion caused by this dangerous compound at Quenast, in Belgium. About 1,800 kilos were being conveyed in a waggon to the quarries belonging to M. Zaman, where it was to be used for blasting purposes, but while it was being removed from the waggon a tremendous explosion occurred. Ten persons were killed instantaneously. A large store close by was quite destroyed, and the houses, trees, and fields within an area of 500 yards were devastated. Fortunately the quarrymen were not at work at the time, or the explosion would have been a still greater calamity, there being about 700 men employed in the works.

Death of Professor Matteucci.—The Italian papers record the death of Professor Matteucci on Friday morning last, at Florence, after a short illness. The deceased was an Italian senator and Minister of Public Instruction, in which capacity he was very active in promoting the extension of education. But he was better known as a man of science than as a politician or a minister. He obtained, in 1844, the prizes of the French Academy of Sciences and the Copley Medal of the Royal Society for his investigations in electro-physiology. His "Lectures on Physics" passed through four editions. He published also "A Manual of Telegraphy," "A Treatise on Electro-physiological Phenomena," "Elements of Electricity as applied to the Arts," and "Lectures on the Physico-chemical Phenomena of Living Bodies," which has been translated into English and French.

Behaviour of Albumen and Fibrin in Air free from Dust.—Dr. Gunning relates a remarkable instance of the different behaviour of these two substances; in the year 1862 he repeated some of the well known experiments of Pasteur concerning the behaviour of some organic substances prone to rapid decomposition, while kept in air free from dust, and so that dust can have no access to the substances under trial. In the above-named year Dr. G. took fibrin obtained from blood by agitating it with small twigs and washing it with water; it was then placed in bottles (ordinary large water bottles of from 2 to 3 litres cubic capacity) covered with water, while afterwards, in the neck of the bottle, a piece of cotton wool was placed; a rapid current of steam was now passed into the bottle through a glass tube which reached to the bottom of the bottle, and continued for about 20 minutes; the tube was carefully raised while steam was yet passing and without disturbing the tuft of cotton immediately after the neck and mouth of the bottle was covered over with a piece of filtering paper, and the bottle left to itself. At the end of 1867, the water standing over the fibrin had not even become turbid, and the fibrin itself was unaltered. A similar experiment, made with albumen (obtained from eggs by diluting the white of eggs with water, filtration, coagulation by heat, and addition of a few drops of acetic acid, and careful washing of the coagulum previous to being placed in a bottle, in a similar manner as just described for fibrin), proves also, at the end of the year 1867, that under the same circumstances albumen always undergoes a change, but one essentially different from that which it undergoes when exposed to ordinary air. No infusoria, or mouldiness is seen; the albumen becomes slowly dissolved and, provided the bottle is not exposed to light, the resulting liquid is hardly more than just yellowish coloured, but milky; no sulphuretted hydrogen is given off, but the sulphur originally contained in the albumen is found as sulphuric acid. The liquid contains, moreover, ammonia, butyric and valerianic acids; on evaporation it yields a

substance which represents, in bulk and weight, only a small portion of the albumen originally submitted to the experiment.

Utilisation of Sewage.—Some experiments just completed at Tottenham seem likely to throw some light on this question. A new mixture of several chemical ingredients introduced by Mr. Sillar has been tried on a large scale, and with considerable success, the impurities being precipitated more rapidly than by either the alum or the lime process. The proportion of the organic matter carried down is very large, and 85 per cent of the ammonia is fixed. At Tottenham a 5000 gallon tank was filled and precipitated eight times in succession, the average time occupied being but little more than 20 minutes. The analysis of the supernatant water shows that it contains but 2 grains per gallon more organic water than the Tottenham water supply, and of its saline constituents by far the larger proportion is common salt—the refuse of a manufactory. The mud has since being dried, and weighs about 8 cwt. It contains enough ammonia to make it in all probability a remarkable article; and its value is expected to pay all expenses. 40,000 gallons were afterwards purified in a larger tank, the time occupied, including filling, was less than an hour; the water was almost free from either taste or smell. Some larger experiments are about to be tried under the direction of Mr. Wigner in another town.

ABSTRACT OF ANALYSIS OF SEWAGE, &c.

Mr. Sillar's Process.

	Average Sewage.	Average Water from Sewage.	Tottenham Water.
Total solid matter, per gallon	203.89	81.96	48.70
Organic matter	109.20	14.62	11.31
Ammonia	3.97	.584	—
Phosphoric acid	7.23	—	—
Common salt	57.10	57.51	9.21
Silica, alumina, and various salts	30.36	9.82	28.18

MANURE OR SEWAGE RESIDUE.

Water	4.45
Organic matter containing ammonia	2.37
Phosphoric acid	5.33
Sulph. lime	1.67
Silica, alumina, and various salts	68.50

100.00

Chemical Promotions.—There is some stir in the chemical world *apropos* of existing vacancies and probable promotions. Unfortunately the number of remunerative offices which can be held by scientific chemists in this country is small, and the emoluments, for the most part, are absurdly insufficient. That accomplished chemical pluralist, Dr. Frankland, having resigned one of the least lucrative of his positions, Dr. Odling will succeed him—whether wholly or in part, seems not quite clear. Dr. Odling will, we believe, associate with himself a co-lecturer at St. Bartholomew's Hospital; and this will probably create a vacancy in the chemical chair of another metropolitan medical school. Dr. Lyon Playfair will also, it is understood, vacate the chemical chair in the University of Edinburgh, in the case of his election to represent the University in Parliament. It is expected that he will be succeeded by Dr. Anderson, Professor of Chemistry in the University of Glasgow.—*British Medical Journal*.

[The above paragraph is not quite correct. Dr. Odling has been appointed Fullerian Professor of Chemistry at the Royal Institution; not, however, *vice* Dr. Frankland, resigned, but in the place of the late Professor Faraday. Dr. Odling's co-lecturer at St. Bartholomew's Hospital will be Dr. Matthiessen; and the vacancy which this will occasion at St. Mary's will probably be filled up by Dr. Russell.]

Department of Science and Art.—In our number for May 3rd, 1867 (*Am. Repr.*, July, 1867, page 41), we published a letter from a correspondent announcing that the Council of Education had offered to make payments to science teachers to enable them to visit the Paris Exhibition, and for any reports or useful suggestions which they might make (in respect to their duties or teaching) derived from the study of the Exhibition, and offered further sums of £20, £15, and £10 for the best of such reports referring to instruction in science. We now learn that on examining the reports sent in, it appears that the *best* do not fulfil the conditions of the minute. The Lords of the Science and Art Department have therefore made special grants as follows, viz., to Mr. Shore of Burnley, and Mr. E. A. Davidson of London, £15 each; and to Mr. Mayer of Glasgow, Dr. Wilson of Nottingham, Rev. B. W. Gibsons of London, and Mr. Bolam of Leith, £10 each. One section of Mr. Gibsons's prize report has already appeared in the *CHEMICAL NEWS*.

The Atmosphere of the Metropolitan Railway.

—The attention of whatever authorities may exist for the control and direction of railways must be earnestly invoked to the frightful state of the atmosphere—we beg pardon for misusing the term—in the Metropolitan Railway tunnels. Several persons died in these shamefully neglected passages during last summer, and, if one is to look at the present state of the line, they died in vain. Something was done or said to have been done, and scientific witnesses of great distinction distinguished themselves by reassuring the public mind as to the salubrity of the tunnels. The company produced their own servants in such blooming states of health that some folks were expected to reside permanently in the carriages "for the benefit of the air." Still, however, in the worst part of the railway, *i.e.* from King's Cross to Baker Street, the heat is often so great that perspiration streams over travellers' faces, and the effect of the want of ventilation is so painful that scores drag themselves faintly up the steps at the stations. If there is no reason why the atmosphere of a coal-pit should be maintained in London, the tunnels ought to be properly ventilated. Two or three shafts placed after the manner of mines with furnaces at their feet would serve the purpose. It is not needful to place such shafts immediately over the arch and in the middle of the highway, but some wisely-selected spot would suit on that "surplus property," which is said to be worth a million, and to be in the hands of the company. We do not assert that the company actually possesses so vast an estate as this sum of a million would imply, but there can be no doubt,—1, that it can afford to ventilate the line; 2, that if Parliamentary authority has enabled it by *compulsory* purchase to obtain so enormous an estate, the sooner that matter is inquired into the better.—*Athenæum*.

Ozone.—The *Journal of the Franklin Institute* for April says that a youthful physicist of its acquaintance, who has one of those collections of chemicals and apparatus known as Crew's Laboratories, while trying the development of ozone by the action of a heated glass rod upon a mixture of air and ether, varied the experiment by substituting oxygen for air and a glass tube for a rod. Under these conditions, a tremendous detonation was the result of the introduction of the heated tube into the mixture. Supposing that the glass might have been too hot, he repeated the experiment, but again an explosion followed, although the tube was not sufficiently hot to burn the closed hand when drawn through it. A glass rod was then tried, but although at a low red heat, it produced no such result. The explanation is obvious. The position of mixed gas and vapour inside of the tube, being confined, was so completely acted upon that ozone in sufficient purity and bulk to ignite the vapour or mixture was produced; while in the case of the rod, that part of the oxygen converted into ozone at each instant was too rapidly diffused and diluted for such a result.

CONTEMPORARY SCIENTIFIC PRESS.

[Under this heading it is intended to give the titles of all the chemical papers which are published in the principal scientific periodicals of the Continent. Articles which are merely reprints or abstracts of papers already noticed will be omitted. Abstracts of the more important papers here announced will appear in future numbers of the "CHEMICAL NEWS."]

Comptes Rendus. March 16, 1868.

PAYEN: "A Method for Extracting Cellulose in an unaltered condition from the Epidermis of Plants."—A. STRECKER: "On a new mode of Formation of Organic Sulpho-acids. On the Transformation of Uric Acid into Glycolic."—G. FRIEDEL and A. LADENBURG: "On an Oxychloride of Silicon."—A. BECHAMP: "On the Reduction of Nitrates and Sulphates in certain Fermentations."—MAUMENE: "Note on the Composition of the Potash obtained from Suint, apropos of Chevreul's paper 'On Manures, &c.'"

March 23, 1868.

CHEVREUL: "On the Presence of Copper in Organized Bodies."—BERTHELOT: "On the Pyrogenous Hydrocarbons."—A. DESCAMPS: "On the Double Cyanides analogous to the Ferrocyanides and Ferricyanides."—L. SAVAËGE: "Note apropos of Housseaume's Papers respecting the Decomposition of Iodide of Potassium by Sulphuric Acid."

Annalen der Chemie und Pharmacie. March, 1868.

A. BUTLEROW and M. OSSOKIN: "On the Synthesis of Alcohols, and on the Chemical Constitution of Ethylene."—A. BUTLEROW: "On some Hydrocarbons of the Series C_nH_{2n} ."—A. POPOFF: "On the Isomerism of the Ketones. On Ethylidimethylcarbinol."—R. OTTO: "On some Derivatives of Benzol and Tolual."—H. LIMPRICH and H. SCHWABERT: "On some Compounds of the Tolual Series."—R. OTTO: "Note on the Action of Nascent Hydrogen on Benzoylglucic Acid."—A. W. HOFMANN: "On the Preparation of Methylglucic Acid."—E. EISENMEYER: "On the Dicarboxylic Acids obtained from Chloride of Ethylidene."—A. FRIEDEL: "Note on a new Reaction of Albuminoid Substances."

Annales de Chimie et de Physique. February, 1868.

A. HOUZEAU: "On the Estimation of Minute Quantities of Peroxide of Hydrogen."—BERTHELOT: "On some Chemical Apparatus: (1) An Improved Gas Lamp; (2) Pipette for Transferring Gases; (3) An Apparatus for Decomposing Formic Acid; (4) An Apparatus for the Synthesis of Acetylene. A new Thermometer for indicating Temperatures above the Boiling Point of Mercury."—THIERCELIN: "On the Nitrate of Soda Deposits of the Province of Tarapaca, Peru."

Comptes Rendus. March 30, 1868.

P. SCHUTZENBERGER: "On a New Platinum Compound."—TERRELL: "On the Analysis of Minerals: Action of Ammoniacal Salts on Nitrate Carbonates."—H. DEBRAY: "Researches on the Combinations of Molybdic Acid with Phosphoric Acid."—A. HOUZEAU: "Answer to L. SavaËge's Remarks on the Author's Papers respecting the Decomposition of Iodide of Potassium by Sulphuric Acid."

Poggendorff's Annalen der Physik. No. 2, 1868.

P. GROTH: "Contributions to the Knowledge of the Perchlorates and Permanganates."—A. FOSTER: "An Account of some Methods of Preparing Phosphorescent Compounds."—W. MÜLLER: "On the Method of Preparing and Properties of Soft Yellow Sulphur."

Bulletin de la Société Chimique de Paris. January, 1868.

A. GAUTIER: "On Acetonitrile and Propionitrile."—BERTHELOT: "On Oxysulphide of Carbon."—A General Method of Reducing and Saturating Organic Compounds with Hydrogen."—THIERCELIN: "On the Nitrate of Soda Deposits of Peru."—E. BOUQUIN: "A General Theory of the Electrolysis of Organic Acids and their Salts."—On the Electrolysis of Formic Acid."—P. BEHARD: "Note on Cananda Wax."—SCHNEIDER-KESTNER and ROSENSTIEL: "Note on the Composition of the Residues left after roasting Iron Pyrites."

February, 1868.

THIERCELIN: "On the Nitrate of Soda Deposits of Peru." LAUTH: "On the same Subject."—CLOVE: "On the same Subject."—E. BOUQUIN: "Researches on the Electrolysis of Organic Acids and their Salts."—JUNGFLICHS: "Researches on a Second Series of Chlorinated Derivatives of Benzene."—G. TISSANDIER: "Analysis of the Water of the Mineral Spring of Villa Salice, near Voghera, Piedmont."—DEBRAY: "Researches on Dissociation."—E. BOUQUIN: "On the Electrolysis of Camphoric Acid."—BERTHELOT: "A General Method for Reducing and Saturating Organic Compounds with Hydrogen."—On the Formation of Acetylene in incomplete Combustions by Means of the Voltaic Battery. "On some Thermo-chemical Phenomena which accompany the Reaction of Hydriodic Acid on Organic Matter."—On some General Conditions which affect Chemical Reactions."

Journal für Praktische Chemie. March, 1868.

RITTHAUSEN: "On Vegetable Casein or Legumin."—E. FREYNIUS: "On the Composition and Properties of the Rothholz (par-

tially Carbonised Wood), manufactured by the Chemical Products Company at Mayence."—G. STADLER: "On the Constitution of Sulphophenyllic Acid."—Note on Anisic Aldehyde."—On the Preparation of Permanganate of Potash."—A. ELLENBURG: "On the Formation of Sugar in the Liver."—K. VON HAUER: "On the Relative Solubility of Isomorphous Salts and Mixtures of the same."—K. HAUSHOFFER: "On the Decomposition of Granite by Water."—H. HERMANN: "On the Composition of the Columbite, and on the Preparation of the Acids of Tantalum, Niobium, and Ithium from that Mineral."—F. ULLIK: "On some Compounds of Tungstic Acid."—F. VON KOBELL: "On Typical and Empirical Formulae of Mineralogy."—F. KENDEL: "On Hatchett's Brown, and on a Triferrocyanide of Sodium and Potassium."—W. STEIN: "On the Manufacture of Ultramarine Paper, and on the Action of Neutral Alum on Ultramarine and Hyposulphite of Soda."—E. MÜLLER: "On Sulphocarbamic Acid and some of its Salts."

Comptes Rendus. April 13, 1868.

H. DEBRAY: "On the Formula of Molybdic Acid, and on the Equivalent of Molybdenum."—L. TROOST and P. HAUTEFILLE: "On the Production of Paracyanogen, and on its Transformation into Cyanogen."—H. CARON: "On the Use of Fluoride of Calcium in Smelting Iron Ores containing Phosphorus."—P. SCHUTZENBERGER: "On the Crystallisation of Sulphur."—On some Chemical Reactions which give rise to the Formation of Oxychloride of Carbon."—CHEVREUL: "On the Amides of Sulphocyanophosphoric Acid."

April 20, 1868.

A. WURTZ: "On the Identity of Artificial Neurine with that obtained from the Brain."—L. TROOST and P. HAUTEFILLE: "On the Production of Paracyanogen, and on its Transformation into Cyanogen."—JEANNEL: "On the Preparation of the Salts of Sesquioxide of Iron and on Oxychloride of Iron."—F. JEAN: "Note on the Manufacture of Phosphate of Soda and of Fluoride of Sodium."—P. SCHUTZENBERGER: "On a New Acetate of Chromium."—C. FRIEDEL and A. LADENBURG: "On some Derivatives of the Radical Silico-Allyl."

April 27, 1868.

SAVARY: "On a Sulphur, Carbon, and Salt Water Battery."—P. LE ROUX: "On the Introduction of a Cylinder of Magnesia into the Voltaic Arc for the purpose of increasing and steadying the Light produced."—H. CARON: "On the Preparation of Magnesia to be used for the Manufacture of Refractory Articles."

Annales des Mines. No. 5, 1867.

N. KOKSCHAROW: "On the Decolouration of the Topaz."—GORTZ: "On some Minerals which may be found associated with the Diamond."—CZECH: "On a Specimen of Crystallised Graphite."—NAUMANN: "On the Pyro-Electricity of Quartz."—STRENG: "On the Composition of certain Silicates."—FUCHS: "On the Specific Gravity of certain Silicates."—GUTH: "On the Composition of Garnet."—J. A. MICHAELSON: "On the Composition of Hornblende."—HERMANN: "On Wöhlerite, Eschynite, and Euzeinite."—HAIDINGER: "Analysis of Meteoric Iron from Dakota, India."—BORCHG: "Analysis of Meteoric Iron from Carthage, North America."—REICHAERT: "On Kainite from Staßfurt, Prussia."—BREITHAUPT: "On the Presence of Magnesia in Arragonite."

Annales de Chimie et de Physique. March, 1868.

J. L. SORET: "Researches on the Density of Ozone."—J. B. BOUS-SINGAULT: "On the Functions of Leaves."

Archives des Sciences. April 15, 1868.

H. WILD: "On the Absorption of Light by Dry and Moist Air."

Bulletin de la Société Chimique de Paris. March, 1868.

BERTHELOT: "A General Method of Reducing and Saturating Organic Compounds with Hydrogen."—LECOQ DE BOISBAUDRAN: "On the Supersaturation of Saline Solutions."

Dingler's Polytechnisches Journal. April, 1868.

P. VON TUNNER: "On Oudry's Method of Depositing Copper on Iron by Voltaic Electricity."—REICHERT: "On the Manufacture of Magnesium from Carnallite."—C. NOLLNER: "On a Compound of Bichloride of Tin and Chloride of Sodium. On an Explosion of Hydrogen in a Vacuum Pan at the Kuttentberg Sugar Refinery."

Journal für Praktische Chemie. March, 1868.

H. RITTHAUSEN: "On Vegetable Casein or Legumin. On the Products of the Decomposition of the Legumin and the Protein Compounds of the Lupine and Almond by Boiling with Sulphuric Acid. On Glutamic Acid, a Product of the Decomposition of Glutamic Acid by Nitrous Acid."

Kunst- und Gewerbeblatt. March, 1868.

M. ZANGERLE: "On the Use of Petroleum as Fuel."—W. A. HEER: "On the Manufacture of Artificial Precious Stones."—J. B. SCHÖBER: "Analysis of Polyhalite from Berchtesgaden, Bavaria."

May 4, 1868.

BOULAY: "Note on a New Constant Battery."—L. CAILLETET: "On the Permeability of Iron to Hydrogen at Ordinary Temperatures."—H. CARON: "On the Preparation of Magnesia for use with the Oxyhydrogen Light."—CALLAUD: "On some Experiments at Sea with the Author's Two-fluid Voltaic Battery."

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften zu Wien (Mathematisch-Naturwissenschaftliche Classe).

October, 1857.

J. WOLFF: "A Chemical Examination of the Iron Ores of Huttenberg, Carinthia."—F. VON UCHATIUS: "Some Improvements in the Author's Method of Testing Powder."—A. GRABOWSKI: "On the Tannin of Oak Bark."—G. MALIN: "On Isodulcitol Acid. Contributions to the Knowledge of Camphor."—H. HLASIWETZ and A. GRABOWSKI: "On the Decomposition of Camphoric Acid by Cautic Alkalies."—M. REISER: "An Analysis of the Mineral Spring at Sauerbrunn, Wiener-Neustadt."—A. VIETHALER: "An Analysis of the Sulphurous Spring at Spolato. An Analysis of Water from the River Cetina, Dalmatia. On the Variations in the Composition of the Sea Water of Spolato."—J. OSER: "Researches on Alcoholic Fermentation."

Annalen der Chemie und Pharmacie. April, 1868.

C. GRAEBE: "Researches on the Quinone Group. On the Addition Products of the Aromatic Compounds."—C. G. WHEELER: "On the Behaviour of Oil of Turpentine and Camphor towards Hypochlorous Anhydride."—O. JACOBSEN: "On the Sulpho-acids of the Isomers of Camol."—A. W. HOFMANN: "Further Researches on a new Series of Homologues of Hydrocyanic Acid."—W. HENNEBERG: "Note on Cellulose."—J. VON LIEBIG: "On the Use of Extract of Meat for Domestic Purposes."—H. KOLBE: "A new Process for the Artificial Preparation of Urea."—A. STRECKER: "On the Preparation of Glycocol from Uric Acid."

Poggendorff's Annalen der Physik. No. 3. 1868.

G. VON RATH: "Note on a new Crystalline Form of Silico Acid."

Bulletin de la Société Chimique de Paris. April, 1868.

BERTHELOT: "A general Method for Reducing and Saturating Organic Compounds with Hydrogen."—E. BOUVERGON: "On the Electrolysis of Succinic Acid."—H. GAL: "Researches on the Action of Chloride of Cyanogen on Zinc Ethyl."—PERRET: "An Improved Furnace for the Manufacture of Soda."—LUTHRINGER: "On Geraniosine, a new Red Dye derived from Rosaniline."

Journal für Praktische Chemie. April, 1868.

H. RITTHAUSEN: "On Vegetable Casein or Legumin."—A. KENN-GOTT: "Further Experiments on the Alkaline Reaction of some Minerals."—K. HAUSHOFFER: "On Thomsenite from the Salseser Alp."—BOTTGER: "On the Remarkable Action of Sulphuretted Hydrogen Gas on certain Chemical Substances. On the Use of Antimony as a Substitute for Carbon in Voltaic Batteries. On a Liquid for the Electro-deposition of Platinum on Copper, Brass, German Silver, &c. A Method of Preparing Zinc for receiving a Coat of Paint. On the Use of a Decoction of Quillaya Bark for Blowing Soap Bubbles for Physical Experiments. On the Preparation of a Green Oxide of Chromium. On the Use of Solutions of Shell-lac and Dammar Resin for Producing Spotted or Black Pharaoh's Serpents. On the Preparation of Paper for Producing the Fire-work known as Japanese Lightning. A Simple Process for Preparing a Chemically Pure Oxygen Gas."—H. HLASIWETZ and F. HINTERBERGER: "On the Decomposition of Oil of Turpentine at a Red Heat."

Bulletin de la Société d'Encouragement. February, 1868.

"On the Methods used in La Plata for Preserving Meat for Export to Europe."—DEBRAY: "On some Apparatus and Processes founded on the Dialysis of Gases."

Dingler's Polytechnisches Journal. April, 1868.

A. UNGERER: "On the Use of Strontia and of Ammonia in the Manufacture of Soda."—STOCKHARDT: "On the Treatment of Bran with Hydrochloric Acid and Soda for the Manufacture of Food for Cattle."

Bulletin de l'Académie Impériale des Sciences de St. Petersburg. January 13, 1868.

E. BORSCHOW: "On the Action of Nitrous Oxide on Plants."—WERNICHIN: "On the Influence of Chloride of Potassium and Chloride of Sodium on the Assimilation and Excretion of Metallic Iron by a Dog."

Comptes Rendus. June 1, 1868.

BECQUEREL: "Fifth Memoir on the Theory of Electro-capillary Phenomena. On Separating Diaphragms, and on the Influence of Colouring Matters."—H. FIZEAU: "Second Memoir on the Expansion of Solids by Heat."—A. WURTZ: "Note on the Xylenols, two Isomeric Phenols."—A. W. HOFMANN: "Contributions to the Knowledge of Peresulphide of Hydrogen."—CHAPLAIN-COULVIER-GRAVIER: "On the Meteoric Showers of January, 1868."—J. JAMIN and G. ROGER: "On Magneto-Electric Machines."—JAMIN, MAURY, and DESCAMPS: "On the Compressibility of Liquids."—F. CARRÉ: "On the Illuminating Power of the various Carbons used with the Electric Light."—FLAMMARION: "Meteorological Observations taken in a Balloon. Atmospheric Currents. Decrease of Temperature according to the Height attained."—C. DARVET: "On the Existence of Starch in the Yolk of Eggs."—F. JOLYET and A. CAROUES: "On the Physiological Action of Methyl-aniline, Ethyl-aniline, and Amyl-aniline, as compared with that of Aniline."

June 8, 1868.

L. SAUVAGE: "Further remarks apropos of A. Houzeau's Papers on the Decomposition of Iodide of Potassium by Sulphuric Acid."—G. B. HALFORD: "On the Condition of the Blood after Death occasioned by the Bite of a Poisonous Snake."—LAMY and DES CLOITREUX: "Chemical, Optical, and Crystallographical Researches on the Salts of Thallium."—F. P. LE ROUX: "On the Action of the Voltaic Arc on Oxides of the Earths and Alkaline Earths."—F. CAZIN: "On the Expansion and Contraction of Saturated Vapours."—L. FILHOL: "On the Use of Nitroprusside of Potassium as a Test for Alkalinity."—J. Y. BUCHANAN: "On Chloropropionic Acid."—C. SAIX: "Note on a Process for the Artificial Production of Diamonds."

Bulletin de l'Académie Royale des Sciences de Belgique. March 7, 1868.

STAS: "Report on T. Swarts's Memoir on the Transformation of Saturated Compounds into Non-saturated Compounds."—F. DONNY and SEUCH: "Note on the Detection of Arsenic."—T. SWARTS: "Memoir on the Transformation of Saturated Compounds into Non-saturated Compounds."

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften zu Wien. (Mathematisch-Naturwissenschaftliche Classe.) November, December, 1867.

G. TSCHERNMAK: "On some Minerals from Joachimthal, Bohemia, and Kremnitz, Hungary."—V. VON LANG: "On the Crystalline Form of Anorthite, from the Meteorite which fell at Juvenas, France, on the 15th of June, 1821."

Poggendorff's Annalen der Physik. May 4, 1868.

E. GERLAND: "On the Electro-motive Force developed by the Action of Water on certain Metals."—K. HOFMANN: "On the Double Decomposition of Saline Solutions, and on the Density and Refractive Index of Saline Solutions of Different Degrees of Concentration."—M. SCHWANDA: "On the Action of the High-Tension Electricity developed by Holtz's Machine on Man."—K. W. KNOCHENHAUER: "Researches on the Theory of the Electric Current."—K. GREBS: "Experiments on Ebullition."

Annalen der Chemie und Pharmacie. June, 1868.

R. BUNSEN: "On Rhodium."—R. PELTZER: "On some Substitution Products of Para-oxycarboxylic Acid and Anilic Acid."—J. WISLICHENUS and J. STADNICKI: "On Pyrotritaric Acid, a new Acid produced by the Dry Distillation of Tartaric Acid."—F. BEILSTEIN and A. KÜHLBERG: "On Isomerism in the Benzene Series. Isomeric Dichlorotoluenes and Trichlorotoluenes."—W. MORKOWNIKOFF: "On Acetic Acid."—O. HESSE: "On Conchintine."

Supplement.

H. SCHIFF: "On Oxalidine and Thialidine."—A. HORSTMAN: "On the Relations between the Atomic Weight and Specific Gravity of Elastic Fluids. On the Vapour Density of Sulphide of Ammonium."

Annales de Chimie et de Physique. June, 1868.

E. MASCART: "On the Indices of Refraction of various kinds of Optical Glass."—C. MATTEUCCI: "Physico-Chemical Researches on Electro-Physiology."—E. A. BOUVERGON: "On the Electrolysis of Organic Acids and their Salts."

Bulletin de la Société d'Encouragement. March, 1868.

CHEVALIER: "Note on Mittenzwey's 'Artificial Saffron.'"—TROUVE: "On some Miniature Voltaic Apparatus."

PATENTS.

Communicated by Mr. B. VAUGHAN, F.C.S., Patent Agent, 54, Chancery Lane, W. C.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

1854. R. Elsdon, Brockham, Surrey, and A. Stein, Ryder Street, Middlesex, "Improvements in the manufacture of glass, or similar vitreous substances, and in the application of such substances in the construction of buildings."—Petition recorded June 5, 1868.
1860. J. Dewar, M.D., Kirkcaldy, Fife, N.B., "Improvements in preserving and arresting decay in certain vegetable substances for the purposes of food and manure."
1868. J. Young, Kelly, Renfrewshire, N. B., "Improvements in treating hydrocarbons."—June 6, 1868.
1885. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the treatment of oxide of iron, with a view to its use in blast furnaces."—A communication from A. Deligny, Paris.—June 8, 1868.
1888. W. Ferrie, Monkland Iron and Steel Works, Lanark, N.B., "Improvements in and connected with smelting or blast furnaces."
1890. W. Hamer, Bowdon, and J. Davies, Runcorn, Cheshire, "Improvements in the furnaces of salt pans."
1892. C. W. Siemens, Great George Street, Westminster, Middlesex,

"Improvements in the manufacture of cast steel, and in furnace, and apparatus employed for that purpose."—June 10, 1868.

1509. E. R. Southby, Lanark, N. B., "Improvements in utilising oleaginous acid waste."

1512. W. E. Newton, Chancery Lane, "An improved adhesive cement, applicable to uniting china, leather, and other hard and soft substances."—A communication from C. D. Peasley, Biddeford, Maine, U.S.A.—June 11, 1868.

1520. A. L. Henry, Boston, Massachusetts, United States of America, "Improvements in treating quartz and silicious substances to obtain hydrate of silica, and in applying the same to various useful purposes."

1523. J. Gray and R. Weir, Glasgow, N. B., "Improvements in treating ores and in refining crude metals, in order to obtain steel, copper, tin, and lead, and in apparatus therefor."—June 12, 1868.

1528. W. E. Gedge, Wellington Street, Middlesex, "A new chemical product applicable to the electrical pile, and to other purposes."—A communication from P. Rondel, Passage des Petites Ecuries, Paris.—Petition recorded April 17, 1868.

1444. W. R. Lake, Southampton Buildings, Chancery Lane, "An improved mode of, and apparatus for generating gas, and mixing the same with atmospheric air, for heating and illuminating purposes."—A communication from J. T. Rich, Philadelphia, Penn., U.S.A.—May 2, 1868.

1504. J. Oakden and J. Picken, Congleton, "A new or improved material for enamelling iron so as to prevent corrosion and incrustation."—June 20, 1868.

1521. A. L. Fleury, Boston, Mass., U.S.A., "Improvements in the means of, and apparatus for, treating gold and silver ores, and in utilising the products resulting therefrom."—June 12, 1868.

1532. C. Humphrey, Suffolk Grove, Southwark, Surrey, "Improvements in the preparation of a flexible compound applicable to waterproofing and other purposes."

1539. W. Yates, Duke Street, Westminster, "Improvements in the furnaces to be used in metallurgical operations."

1540. K. Malster, Pall Mall, "An improved mixture or compound for cleaning gloves and other articles."

1544. E. Fisher, Grosvenor Park, Camberwell, Surrey, "An improved tonic effervescent drink."—June 13, 1868.

1554. W. C. Sillar, Cornhill, London; G. Sillar, Grange Road, Upper Norwood; and G. W. Wigner, Camberwell, Surrey, "Improvements in deodorising and purifying sewage, and making manure therefrom."—June 15, 1868.

1570. J. C. Walker, Surrey Street, Strand, Middlesex, "An improved baking powder to be employed in the treatment of flour in the manufacture of bread and other farinaceous food."—June 17, 1868.

1541. J. Lewthwaite, Woburn Place, Middlesex, "Improvements in treating the material known as 'parkesine', and in applying it to various useful and ornamental purposes."—Petition recorded March 4, 1868.

1566. J. J. Harrop, Manchester, and W. Corbett, Clayton, near Manchester, "Improvements in the production of iron and steel from ores and from waste products containing iron, as in cases of hammer slag, forge cinder, and the residue arising from the manufacture of sulphuric acid from iron pyrites."—May 23, 1868.

1549. A. Prince, Trafalgar Square, Middlesex, "Improvements in the manufacture of metal castings."—A communication from E. L. Brown, Philadelphia, Penn., U.S.A.—June 5, 1868.

1545. C. E. Schwartz, Aske Street, Hoxton, Middlesex, "An improved mode of, and means for, obtaining crystal brocatel colours."—June 13, 1868.

1548. L. S. Thomassin, Rue d'Enghien, Paris, "Improvements in the process of, and apparatus for, producing combustible and illuminating gas."—June 15, 1868.

1572. A. M. Clark, Chancery Lane, London, "Improvements in the purification of ceramic, vitrifiable, and other matters, as also of the crucibles, furnaces, or vessels used for containing the same."—A communication from L. Clémendot and E. Rousseau, Boulevard St. Martin, Paris.—June 17, 1868.

1550. C. Hengst, and H. Watson, Fulham, Middlesex, "An improved mode of, and means for, manufacturing gas for lighting and heating purposes."—June 18, 1868.

1534. J. Mitchell, Bradford, Yorkshire, "Improvements in furnaces."—June 24, 1868.

1545. E. Lever, Denton, Lancashire, "Certain improvements in the preparation or coating of woven fabrics which are to be subsequently rendered liquid proof or non-inflammable."

1548. Rev. H. Highton, M.A., Brighton, Sussex, "Improvements in the manufacture of artificial stone or slate, and in colouring the same."—June 25, 1868.

1561. L. Thomas, Leadenhall Street, London, "A new or improved apparatus to be used along shore, for the distillation of pure water from salt water or water impregnated with earthy or other matters."—June 25, 1868.

1555. P. R. Hodge, Adam Street, Adelphi, Middlesex, "Improvements in, and application of, the use of hydrocarbonaceous fluids in combination with highly attenuated or super-heated steam for the purposes of smelting, melting, reheating, and working of metals, glass, porcelain, or calcareous materials."

1557. J. Braggs, High Holborn, Middlesex, and F. Brady, Camberwell, Surrey, "Improvements in the extrication and condensation of ammonia, and in the manufacture of ammoniacal salts."

1572. W. F. Deane, Farnworth, near Bolton, Lancashire, "Improvements in obtaining oxide of manganese from a certain residual product of the manufacture of chlorine."—June 27, 1868.

1542. E. Mucklow, Manchester, "Utilising refuse tanning matter for dyeing purposes."—Petition recorded June 25, 1868.

2129. J. B. Brown, Walker, Northumberland, "Improvements in furnaces for calcining ores and other mineral substances."—July 3, 1868.

2137. E. H. Newby, King William Street, London, "Improvements in reducing aluminium from its ores or earths, and in producing alloys therefrom."—A communication from A. L. Fleury, Boston, Mass., U.S.A.—July 4, 1868.

2144. A. Fryer, Manchester, "Improvements in the mode of treating, for evaporating and concentrating purposes, cane juice, beet-root juice, and other saccharine and other solutions and liquids, and in the construction of apparatus for the concentration of saccharine and other solutions and for the evaporation of liquids."—July 6, 1868.

2148. G. Davies, Serle Street, Lincoln's Inn, Middlesex, "Improvements in dyeing."—A communication from A. J. J. d'Andiran and G. Wegelin, Paris.

2152. E. Coppée, Hajne St. Pierre, Belgium, "Improvements in the construction of coke-furnaces."—July 7, 1868.

NOTICES TO PROCEED.

496. H. A. Bonneville, Rue du Mont Thabor, Paris, "Certain improvements in compound of aniline colours."—A communication from E. Zinssmann, New York, U.S.A.—Petition recorded February 14, 1868.

686. G. Sanderson, Worksop, Nottinghamshire, "Improvements in the manufacture of iron and steel."—February 28, 1868.

1455. A. C. Henderson, Charing Cross, Middlesex, "Improvements in the mode of manufacturing albumen, and in the apparatus connected therewith."—A communication from L. Lévy, Paris.—May 6, 1868.

535. W. Perkins, Russell Place, Fitzroy Square, Middlesex, and G. G. Tandy, Anerly Road, Penze, Surrey, "An improved preparation or compound applicable for insulating electric conductors, and for such purposes as india-rubber and other vulcanisable gums are applicable."—Petition recorded February 18, 1868.

565. W. Weldon, Park Villa, West Hill, Highgate, Middlesex, "Improvements relating primarily to the manufacture of chlorine by means of regenerated oxides of manganese, but partly applicable also to other purposes, being improvements in the decomposition of chlorine residues in the peroxidation of oxides of manganese recovered therefrom, in the treatment of a bye-product of the decomposition of those residues, in the separation of sulphuric acid and other impurities from the hydrochloric acid employed, and in apparatus and arrangements for some of these purposes."—February 20, 1868.

688. J. Giers, Middlesborough, Yorkshire, "Improvements in the manufacture of cast steel and homogeneous iron, and in furnaces applicable thereto."—February 28, 1868.

933. E. Vignier, Fowkes Buildings, London, "Improvements in distilling and rectifying spirits, and in apparatus employed therein."—March 23, 1868.

1522. C. W. Siemens, Great George Street, Westminster, "Improvements in the manufacture of cast steel, and in furnaces and apparatus employed for that purpose."—June 10, 1868.

662. W. Weldon, Park Villa, West Hill, Highgate, Middlesex, "Improvements in the regeneration from chlorine residues of oxides of manganese suitable for use again in the manufacture of chlorine, and capable of being applied also to other purposes."—Petition recorded February 27, 1868.

753. C. Schinz, Faubourg de Saverne, Strasbourg, France, "A process for the partial elimination of the nitrogen from the products of combustion, and furnaces and apparatus connected therewith."—March 4, 1868.

901. W. E. Gedge, Wellington Street, Strand, Middlesex, "Improved fuel, by the use of which the kindling of fires will be greatly facilitated."—A communication from K. N. Legendre, Passage des Petites Ecuries, Paris.—March 17, 1868.

1519. J. Norman, Glasgow, N.B., "Improvements in calcining, burning, or oxidising ores, minerals, metals, and other substances, and in reducing oxides and salts of metals and other substances, and in apparatus for these purposes."—May 9, 1868.

1839. W. Firth, Burley Wood, near Leeds, "Improvements in deodorising petroleum and other oils."—June 4, 1868.

1860. J. Dewar, M.D., "Improvements in preserving and arresting decay in certain vegetable substances for the purposes of food and manure."—June 6, 1868.

1940. K. Maltster, Pall Mall, Westminster, "An improved mixture or compound for cleaning gloves and other articles."—June 23, 1868.

1572. A. M. Clark, Chancery Lane, "Improvements in the purification of ceramic, vitrifiable, and other matters, as also of the crucibles, furnaces, or vessels used for containing the same."—A communication from L. Clémendot and E. Rousseau, Boulevard St. Martin, Paris.—June 17, 1868.

1541. J. Lewthwaite, Woburn Place, Middlesex, "Improvements in treating the material known as 'parkesine', and in applying it to various useful and ornamental purposes."—Petition recorded March 4, 1868.

775. J. M. Stanley, Rhyl, Flintshire, "Improvements in the construction of furnaces."

776. J. Whittaker, Manchester, "Certain improvements in the preparation of paper to be employed in the manufacture of waterproof paper."—March 6, 1868.

856. F. Winsor, Manchester, and J. Swindells, Keyworth, Leicestershire, "Improvements in the manufacture of sulphate of magnesia."—March 11, 1868.

861. M. Rowand, Lewisham, Kent, "Improvements in the treatment or preparation of the ingredients employed in the manufacture of fermented liquors."—March 13, 1868.

1023. J. Jameson, Gateshead, Durham, "Improvements in the preparation of safety paper."—March 25, 1868.

1467. J. Hickmott, Clapham, Surrey, "Improvements in preserving metallic articles from oxidation and decay."—May 5, 1868.

NOTES AND QUERIES.

Analysis of Iron Ores.—I have hit upon a "dodge" lately which saves a great deal of time in the analysis of some kinds of ferruginous minerals. On attempting to dissolve in HCl, a certain residue remains (with hematite ore, for instance); and it is rather a long process to have recourse to fusion with sodic carbonate to separate the silica and iron. I tried fusion with bisulphate of potassa at a dull red heat which converts the iron into a sulphate, leaving the silica beautifully white. The time is, for 1 gram of mineral, about 10 to 15 minutes. Should sulphur and phosphorus be required, they may be obtained by drenching a sample with fuming nitric acid, and manipulating in the ordinary manner. The residue may then be treated with bisulphate, to separate the remainder of the iron from the silica.—W. M. B.

Printing Ink.—Is there any method of extracting printing ink from paper, and if more than one, which is best?—PAPER-MAKER.

Size for Velvet.—I want a very adhesive size by which I can attach either gold or silver leaf on velvet pile. The size must not injure the metals attached, nor the velvet, and to be worked cold when applied.—D. C.

Colour of Oil.—It is well known that few liquid oils retain their normal colour for any length of time, especially if exposed to the light, and in consequence of this, frequent disputes arise in commerce between buyers and sellers on oil contracts. It is very desirable for this and other reasons, to be able to prepare a coloured chemical solution, which might by dilution, or otherwise, be made to represent say—refined petroleum, heavy and light; refined coal oil, ditto; refined rape oil; refined cotton seed oil, &c.; and at the same time remain permanent whether kept in the light or dark. Perhaps some reader of the CHEMICAL NEWS could assist us in this matter?—OIL REFINER.

Potato Powder.—Will any of your correspondents kindly tell me how to reduce potatoes to powder? All my attempts at drying them convert them to a tough, discoloured, leather-like mass.—A CONSTANT SUBSCRIBER.

Colour of Oil.—The suggestion of "Oil Refiner" is plausible enough, but without samples of oils of guaranteed purity, and as fresh as desirable to the trade, it would be rather guess and haphazard work to make, or try to make what "Oil Refiner" desires; in a perfectly pure state, all the fixed oils are either only slightly yellowish-coloured, or even perfectly colourless—as, for instance, cold drawn castor oil—or exhibit a peculiar tinge, *ad genera*, belonging to the genuine oil itself, hampseed oil, *a. g.*, being of a greenish hue. Much of the colour of the fixed oils is due to, and derived from, the integuments of the seeds from which they are obtained, or dependa, as is the case with raw cotton-seed oil, upon the presence within the seed of small cells filled with an oleo-resinous-coloured matter, which gets dissolved in the raw oil, in consequence of the breaking of the cells, when pressure is applied to the seed to obtain the oil.

Printing Ink.—The great bulk of printing ink consists of what in chemical parlance is anhydride of linoleic acid ($C_{17}H_{33}O_2$); this material presents, in many of its properties, a great similarity to caoutchouc, like which it may be regarded as a product of oxidation. I have instituted a few experiments to wash both old printing ink, and more recent, out of paper, and find that chloroform answers this purpose best; benzol, coal-tar oil, and the light petroleum oil have no effect whatever; sulphide of carbon does not act very satisfactorily; and I cannot also speak very favourably of oil of turpentine. Next to chloroform, I find that caustic soda answers best; but it at once also disintegrates the paper, converting it into pulp, while evidently the anhydride of linoleic acid, in other terms the boiled linseed oil, is completely dissolved and removed from the paper. The very minutely-divided lamp-black, carbonaceous matter, added to the boiled oil, becomes dispersed through the paper pulp, giving it a greyish tinge; by bleaching agents, however, this tinge gets changed to white. If "Paper Maker" desires more information on the subject—how best to use chloroform in a manner consistent with the expense, volatility, and other difficulties which are in the way—I shall be happy to convey to him such information; but, as it would be taking too much space to do so in these columns, I therefore suggest, if so inclined, that "Paper Maker" should send his name and address to the Office of the CHEMICAL NEWS.—Dr. A. A.

Sulphur.—I would be glad to know at what temperature sulphuretted hydrogen, given off from the cracker in which sulphate of ammonia is salted, if passed into a long flue, will deposit its sulphur—if it will so deposit it; and how much sulphur escapes from 1000 lbs. vitriol, Sp. Gr. 1.720?—QUESTER.

Potato Powder.—First get the potatoes well washed, then slice them, and after this submit them for some time, while placed on hurdles made of wicker-work, to steam of a pressure of from four to five atmospheres; or sixty to seventy-five pounds pressure per square inch; this has the effect of very rapidly boiling the potatoes without causing them to lose in good quality. After this the hurdles containing them are placed in a room through which dry air, having a temperature of at least from 30° to 45° C. is forced by means of a fan-blast; this rapidly dries the potatoes, and if it be desired to reduce them to powder, it might be easily accomplished by first strongly compressing them so as to form solid cubes or cylinders, and to submit these to the action of rasp-mills, similar to those in use to grind snuff from tobacco.

Separation of Arsenic and Antimony.—An accurate method of separating these two bodies is founded on the fact that recently precipitated sulphide of arsenic is soluble in bisulphite of potash, while sulphide of antimony is insoluble. If, for example, we have to analyse a commercial grey sulphide of antimony, or metallic antimony, it can be done as follows:—Mix the finely-pulverised and weighed substance with a little sulphur, and digest in a solution of protosulphide of potassium; the mass dissolves, generally leaving a black residue, consisting

of a mixture of sulphides of lead, iron, and copper, which must be filtered off and examined separately. The liquid is mixed and then heated with a large excess of water saturated with sulphurous acid, then heated and kept in ebullition till two-thirds of the water has boiled away and there is no smell of sulphurous acid. Sulphide of antimony will be precipitated, and from the filtrate from this the arsenic may be precipitated by a stream of sulphuretted hydrogen gas.—F. WOHLER.

Separation of Bismuth from other Metals.—The best way to separate bismuth from other metals is based on the fact that when a large quantity of water is added to its solution mixed with hydrochloric acid a completely insoluble precipitate of oxychloride of bismuth ($Bi_2O_3 \cdot BiCl_3$) is obtained, which may either be weighed as such or reduced to the metallic state by fusion with cyanide of potassium. To separate bismuth from lead add to the concentrated solution just enough hydrochloric acid to precipitate all the chloride of lead, but so that a few drops of water do not render the liquid turbid. Then add dilute sulphuric acid, the slow action of which is hastened by occasional agitation; finally after having added alcohol and well mixed the whole by renewed agitation allow the sulphate of lead to deposit. This precipitate is to be filtered and washed, first with alcohol containing a few drops of hydrochloric acid, and then with pure alcohol. The bismuth may be precipitated in the filtrate by dilution with a large quantity of water.—F. WOHLER.

Aurine.—Printing Ink.—Noticing Dr. Adrian's remarks on rosolic acid, I have tried unsuccessfully to obtain the dry orange pigment of which he speaks. I first made a hot strong solution of carbonate of soda and saturated it with aurine cake, and then mixed slowly a strong solution of alum until the reaction ceased. I obtained, by washing the precipitate, a fine scarlet lake, but on drying slowly it became a dirty pink-tinted alumina, which becomes scarlet again by damping, and the dirty tint again when dry. The reason aurine solution is not used as red ink is because rosine cake is soluble in cold water, and gives a much brighter colour. Rosine pigments, when kept in a shady room, are almost permanent, but two days' exposure to sun and night air will thoroughly decompose the aurine colour. Nearly all black printing ink is now made of rosin oil.—R. G. B.

Utilisation of Sewage.—I shall be glad to know particulars and names of inventors of the alum and lime processes for the utilisation of sewage mentioned in the notice of Mr. Sillar's new process in No. 448 of the CHEMICAL NEWS (*Am. Reprint*, Sept. '68, page 167).—F. J. R.

Lubricating Composition.—Will any of your practical correspondents inform me through the medium of your valuable paper how to make a good and cheap lubricating composition, suitable and adapted for lubricating rolling mills and hot bearings, which is generally termed "Hot-Neck-Grease"?—ABERKING.

Gallipot Oil.—I have a quantity of Gallipot oil, expressed from shoddy, which is of a very dark colour, originating, I presume, from contact with the dyeing materials used in the manufacture of cloth. Can any of your learned correspondents tell me how to bleach the same, and bring it to its original colour without distilling?—OILMAN.

Indigo.—I have occasion to use a considerable quantity of a solution of indigo, made from the commercial extract of indigo, which, upon the addition of clean cold water, turns a slight green colour, not at all like the original colour of indigo. Can any of your numerous correspondents tell me how to remedy this evil, and keep the solution of a deep blue, or what substance can I add in order to deepen its colour?—CHEMICAL NOVICE.

Bichloride of Methylene.—Seeing an enquiry in one of your Notes and Queries columns relative to bichloride of methylene, I thought it might be interesting to extract for the benefit of your readers the following account, which Dr. B. W. Richardson gives of this body. It is from the reports of the British Association just published. Dr. Richardson says that bichloride of methylene (CH_2Cl_2) is formed by the action of nascent hydrogen on chloroform, and it differs from chloroform, in that one atom of chlorine is replaced by an atom of hydrogen. Its boiling point is 88° Fahr., and the colour of its vapour is sweet and much like that of chloroform.—ATKINS HOLLOWAY.

Philosophy of Pie-juice.—I shall be extremely obliged if you will inform me upon what grounds you object to my conclusions on the Philosophy of Pie-juice. I am open to conviction, and I shall be very glad if you will explain the matter for the edification of your readers, as a simple denial or a gratuitous statement without explanation will not I fear convince; at present I believe that sugar baked with the fruit sweetens it, but double the quantity added after does not counteract the acidity; the sugar and acid remain in their original state.—M. A. BAINES.

[The *onus probandi* rests with our correspondent. We said last week that the following assertion had no sufficient foundation: "No amount of sugar will sweeten fruit after it is cooked, for the sugar and the acid will not then amalgamate." It is not surely meant that sugar acts the part of an alkali in neutralising acids. In objecting to the explanation we do not necessarily doubt the fact, corroborated as it seems to be by general household experience, although it appears at variance with scientific notions. Probably a careful examination into the chemistry of the process would throw some light into the hidden mysteries of a raspberry and currant pie.—Ed. C. N.]

ANSWERS TO CORRESPONDENTS.

NOTICE.—The American Publishers of THE CHEMICAL NEWS give notice that in accordance with a suggestion of Mr. CROOKES, the Editor and Proprietor of the English publication, they will be pleased to receive and forward to him in London any scientific publications issued in America, for review—and also any Notes

and Queries, Articles, Correspondence, etc., for publication or reply. Their facilities of communication with Mr. Crookes render this very desirable to all persons in the United States who wish to confer with him. Address.

W. A. TOWNSEND & ADAMS,
434 Broome Street, New York.

E. Roman.—The atomic weights of cobalt and nickel are considered to be identical. If you can prove them to be different it will go far to corroborate the theory you have started, but without some experimental evidence we must decline to fill our pages in the way you propose.

A Soap Maker, who forwards a letter asking for detailed information respecting various kinds of soap, is informed that such queries are considered not to fall within the province of our Notes and Queries. An advertisement will doubtless procure the desired information.

Druggist.—See answer to "Soap Maker."

W. B.—1. Dissolve the white lead in acetic acid: an insoluble residue will denote impurity. 2. "Fresenius's Quantitative Analysis," published by Churchill.

Xylo.—The new green aniline dye.

J. Brode & Co.—We will endeavour to ascertain the address required.

C. G. G.—Apply to Asher's, Bedford Street, Covent Garden.

D. Howell.—"Roscoe's Chemistry," published by Macmillan.

E. Oldreie.—1. Fresenius's "Qualitative Analysis;" to be followed up by a study of his "Quantitative Analysis." 2. Liebig's "Agricultural Chemistry."

J. H. S.—The subject is not of sufficient importance to be worth devoting more space to it. See Mr. Readwin's letter in this number. The most reasonable supposition is that we do not know what was the experiment which the deceased was trying; the evidence before the coroner was not clear on this point.

E. C.—Consult any elementary book on chemistry. We cannot tell the price, until we know in what form it is required.

W. B.—Please repeat the question, spelling the words in full and writing a little plainer.

Alpha.—The book shall be sent.

Lanely writes as follows: "The purpose of my letter is to beg your kind advice as to whether it would be possible for me to obtain a situation where chemistry is taught or practised, and where I might gain my living and learn the art, and ultimately become a practical chemist? If so, where had I best apply? I am very little acquainted with the chemical world, but am intensely attached to the science and art. Had I plenty of means I suppose I would have but little trouble in gaining my heart's desire. I mean I might be trained in a school or college of chemistry; but this is not my lot, I must work to gain my living. I know that for a persevering mind there are few things impossible. I therefore encourage myself, that, although moneyless, I may yet gain, by hard working, the position I long for. I am twenty-one years of age, have been engaged for last two years as a dispenser, &c., to a surgeon, during which time I have devoted almost all my spare time to the study of chemistry, and have got up the elements of organic and inorganic chemistry, chemical philosophy, and chemical analysis. I am really anxious, seeing that in my present employment I can never satisfy my ambition. If you will be so kind as to insert your answer in your next number of the CHEMICAL NEWS, stating the place where I had best apply, and my advantages and prospects in the same, I shall feel extremely obliged." We cannot take the responsibility of advising on this subject. Scientific chemistry, as an amusement for leisure hours, has no rival, but it is the worst trade you can choose. If also you have a definite object in view—some manufacture or trade, in which chemistry can be made available, you will do well to persevere in its study. But having no money or prospects, and being under the necessity of working for a living, we can give you no hope of getting on. Chemistry is not yet remunerated sufficiently for it to be worth any one's while to take to it as a trade. Unfortunately its fascinations are such that hundreds are tempted to enter upon its study with the expectation of being able to earn a living at it. A very small number succeed, but the majority seldom get as much as would satisfy a respectable mechanic or clerk. When an appointment is advertised which will bring in £300 a year, there are 100 applicants; and one in which the expenses of the office are expected to exceed the income is even sought after, if it is likely to prove a stepping-stone to something better.

F. J. R. (Glasgow).—A letter to the gentleman, addressed to our office, will be forwarded. Lehmann's Physiological Chemistry will give you the analyses you require. See also Watts's Dictionary.

An Icicle.—You ought not to require a freezing mixture. One of the best mixtures consists of equal parts of nitrate of ammonia and water. When dissolved a great reduction of temperature takes place. Use a preliminary mixture to cool down the nitrate of ammonia, water, and vessels you intend to employ in the actual operation, and the temperature obtained will be correspondingly lower.

Physician.—It is quite true. Professor Church's paper on the occurrence of arsenic in a potable water, habitually used for every purpose by the inhabitants of a village in Cumberland, will be found at page 123 of our second volume. (Eng. Ed.)

D. Powell.—Such a book as you require is in preparation, and will shortly be published by Messrs. Longmans.

M. A. B.—"The Philosophy of Pie-juice" will not bear very close criticism. The cup we understand, but the explanation given in the following sentence has no sufficient foundation:—"No amount of sugar will sweeten fruit after it is cooked, for the sugar and the acid will not then amalgamate. When the sugar is placed in the pie before baking, as

it always ought to be, the chemical action of the heat favours the effect of the sugar upon the fruit, the acidity is neutralised, and an agreeable amalgamation takes place, which can never be produced by an after addition of sugar to the pie."

W. B.—The cap evidently fitted, but our remarks about indistinct writing were addressed to another correspondent writing under the same initials. The modes of analysing quantitatively and qualitatively commercial white lead and zinc white are too simple to be worth inserting a query for them in our columns. Any modern book on analysis will give you sufficient information to enable you to devise a process best fitted to your special case.

C. Crawford.—There is no discrepancy. It is entirely an arbitrary matter whether you write the N first in ammonia, with Muller and Hoffmann, or the H first, with Roscoe, Williamson, and Frankland.

Chloride of Barium.—Messrs. Gaskell, Deacon, and Co., of Widnes, who are now manufacturing this salt in large quantities, have forwarded to us a small sample for laboratory use. We have tested it and found it to be remarkably free from impurity, and suitable for the preparation of test solutions.

F. J. R.—1. See Notes and Queries. 2. Write to Mr. H. Baillière, 219, Regent Street, W.

A. L. Stevenson.—In our next.

M. Tente de Motay.—Can any correspondent oblige us with the address of this gentleman?

C. E.—We are not aware of the existence of any such society. An advertisement in the French journal *Les Mondes* will be almost certain to procure what you want; it can be sent through our office.

T. H. Heath.—"Gessner on Coal Tar," to be procured at Baillière's.

Communications have been received from H. Hughes; Dr. Calvert, F.R.S.; Dr. E. Rohrig; C. Bailey; D. Howell; C. Greville Williams, F.R.S. (with enclosure); Dr. Attfield; J. Wyld; Messrs. Townsend and Adams (with enclosure); Alexis Lomonosoff; Professor H. Morton (with enclosure); W. M. Bowron (with enclosure); J. Geddes; J. Adolphus; H. Verquin; S. S. Bold; W. May (with enclosure); D. Forbes, F.R.S. (with enclosure); A. Vernon Harcourt, F.R.S. (with enclosure); M. Holdsworth (with enclosure); Professor Heston (with enclosure); D. Clifton; J. Hunter, M.A. (with enclosure); W. White (with enclosure); Beer & Co. (with enclosure); J. H. Freeman (with enclosure); F. A. Genth (with enclosure); Edwards and Bult; J. H. Cox (with enclosure); Rev. A. Kigg (with enclosure); J. Mercer (with enclosure); R. Kunnery (with enclosure); Burnard, Lack & Co. (with enclosure); W. Briggs (with enclosure); Dr. J. Stenhouse, F.R.S. (with enclosure); Prof. Pavest (with enclosure); Bailey and Son; E. Smith; W. W. Biggs; Dr. J. Blyth; P. Holland; and T. Blair; S. Ivanoff; Messrs. Townsend and Adams; Dr. T. L. Philson (with enclosure); E. Oldreie; J. Bowling (with enclosure); H. Bagshaw; W. Little; W. Toulmin (with enclosure); E. Schunck (with enclosure); Alment and Johnson; C. Mitchell and Co.; R. J. Williams; Nicholson, Taylor, and Co.; E. W. Ball; Dr. S. Muspratt (with enclosure); M. A. Gage (with enclosure); J. Cartelghe; J. Napier (with enclosure); Dr. Divers (with enclosure); E. T. Simmons; and C. R. C. Tielhorne; W. W. Abbot (with enclosure); Professor Church (with enclosure); T. Graham, F.R.S. (with enclosure); Dr. Divers; G. F. Rodwell; W. Brown (with enclosure); H. Seward; J. Trechane; A. B. Northcote; E. Owens; W. Archer (with enclosure); J. Attfield (with enclosure); W. Little; F. J. Rowan; Dr. F. C. Calvert, F.R.S. (with enclosure); U. J. Kay Shuttleworth; W. Briggs; J. Nismo; G. W. Eccles; Gaskell, Deacon & Co.; J. Livesey; C. Dixon; C. E. J. Ford; J. Horely; J. H. Freeman (with enclosure); E. P. H. Vaughan; F. Nannin & Co. (with enclosure); H. Baillière; Longmans & Co.; Dr. Rohrig; J. Spiller (with enclosure); J. Greenwood; J. J. Vaughan (with enclosure); H. R. Williams; H. G. Bennet (with enclosure); J. Hinch, Ph.D., Chicago (with enclosure); C. Crawford (with enclosure); W. Bees (with enclosure); Mrs. Baines (with enclosure); W. Walker; G. Andrews; M. Hodgkinson (with enclosure); Dr. Letheby; D. Powell; Major F. T. Rickard; J. Winterbottom; D. R. Beebe, F.R.S. (with enclosure); G. F. Rodwell (with enclosure); Ellis Jones (with enclosure); W. P. Wilson; Dr. Sheridan Muspratt; Capt. Hitchins; J. Ireland, Jun.; Rev. B. W. Gibson, M.A.; Castle & Lamb; Gaskell, Deacon, and Co. (with parcel); A. P. Hurlstone; Dr. J. E. Reynolds (with enclosure); Dr. A. L. Stevenson (with enclosure); W. H. Langford; J. Brode; and Co.; F. J. Rowan; L. Summering; J. Chalmers; R. R. Tatlock; D. Forbes, F.R.S.; Professor Pepper; Prentice (with enclosure); Murray and Heath (with enclosure); Prentice and Co.; J. Reid; Dr. Rohrig (with enclosure); G. F. Rodwell (with enclosure); W. Little; Mrs. Baines; Dr. R. Angus Smith; and J. Ireland, Jun.

Books Received.—"Observations upon a New and Simple Process for the Preservation of Meat and other varieties of Animal Food." London: Simpkin and Co. "What shall we Drink?" By J. L. Denham. London: Longmans and Co. "The Principles and Practice of Photography." By Jabez Hughes. "Brathwaite's Retrospect of Medicine." Vol. 57, January to June, 1863. London: Simpkin and Co. "Photography Manipulation." By Lake Price. Second edition. London: Churchill. "Progetto di Classificazione Tecnologica per una mostra di Prodotti naturali e manfatti." Da G. Arnagdon, Professore nel R. Istituto Industriale di Torino. "On Aniline and its Derivatives." By M. Reimann, Ph.D., L.A.M. To which is added, an appendix, "The Report on the Colouring Matter derived from Coal Tar, shown at the French Exhibition, 1867." By Dr. A. W. Hofmann, F.R.S.; M.M. G. de Laire and Ch. Girard. The whole revised and edited by William Crookes, F.R.S., etc. London: Longmans. "Water Analysis: a Practical Treatise on the Examination of Potable Water." By J. A. Wanklyn and E. T. Chapman. London: Tribner. "Essay on the Comparative Efficiency of Spectroscope Prisms of Different Angles." By Edward C. Pickering.

THE CHEMICAL NEWS.

Vol. III. No. 4. American Reprint.

ON THE TRANSMUTABLE NATURE OF WATER.*

LET us be excused for stating the elementary fact, that when an electric current is passed through water, the water is decomposed, oxygen appearing at one pole and hydrogen at the other; whence chemists have hitherto naturally inferred that water is a compound of oxygen and hydrogen, a conclusion confirmed by other facts of a chemical character. As the battery power increases, the distance between the poles in the decomposing cell may be increased. With still higher power, two cells may be used, one for each pole, and the connection between the two cells may be made by a more or less perfect conductor, such as wet tow, the human body, or moist earth,—the only rule to be observed being that the electro-motive power must be more than sufficient to overcome the resistance introduced into the circuit.

Mr. Wilde, in a lengthy paper in the last number of the *Philosophical Magazine*, has recorded an experiment of the same kind, on a Brobdignagian scale, and has arrived at results which he declines to explain in any such rational manner. His electro-motor, actuated by a 7-horse-power steam engine, has the energy of a lightning flash; his conductors are copper-wire ropes, half an inch in diameter and 140 feet in length; and his decomposing trough is a navigable canal.

In his experiments Mr. Wilde uses an electric current of enormous power, generated by means of the large electro-magnetic machine of his construction; the quantity-armature of which is capable of melting about fourteen inches of iron rod, a quarter of an inch in diameter, and the intensity-armature, seven feet of iron wire, 1-16th of an inch in diameter. The intensity-armature was used, and its currents were turned all in the same direction by means of a commutator.

It appears that the energy of Mr. Wilde's machine is sufficient to decompose water, when the resistance of 200 feet of moist earth intervenes between the terminals.

Three hundred feet of the naked copper rope were extended in one length in a canal, and connected with one pole of the electro-motor. The other pole, having a platinum terminal, was introduced into a pool of water 200 feet from the canal, and a eudiometer tube was inverted over it. Reasoning from small things to great it might be supposed that the electric current would decompose the water, oxygen going to one pole and hydrogen to the other. And this, of course, is exactly what happened.

Instead of explaining these phenomena in the usual manner, Mr. Wilde, after describing how twenty cubic inches of oxygen were collected in six minutes, says that these "represent the transmutation of 6.92 grains of water into the same number of grains of gaseous oxygen at the ordinary atmospheric pressure and temperature. On reversing the polar connections, so that the platinum now formed a negative electrode, twenty cubic inches of hydrogen were generated in three minutes, which volume of gas represents the transmuta-

tion of 0.43 of a grain of water into the same weight of gaseous hydrogen." The gases were obviously evolved in the proportions in which they enter into combination to form water.

The explanation is very simple, and will doubtless have already occurred to most of our readers. It is well stated by Dr. Francis, the Editor of the *Philosophical Magazine*, in a note appended to Mr. Wilde's paper, where he says: "We are of opinion that the supposed conversion of water into oxygen or hydrogen is simply a decomposition of water, the oxygen being evolved in the one pool, the hydrogen in the other, the earth acting as the conductor between the two pools. The large surface of the conducting wire in the one pool would naturally make the amount of gas evolved at that pole appear very small."

Not quite so simple as this is Mr. Wilde's explanation. He gives what he is pleased to call his conclusions in the following phraseology: "When the positive or negative electrode of an electro-motor is plunged into a body of water in contact with the earth, it seems to me that the corpuscular motion of the electrode, by the very act of communicating itself to the molecules of water in immediate contact with it, transforms them into molecules of oxygen or hydrogen, the electric impulse (after leaving the electrode) being then received into the entire mass of the terraqueous globe by a physical conductivity similar to that by which the current is propagated in metallic bodies."

That no doubt may exist as to his opinions being very decided on one point, we need only quote the following expressions:—"In order that no reasonable doubt may be entertained that the oxygen or the hydrogen evolved from the electrode in the pool had no relation whatever to the oxygen or hydrogen liberated on the surface of the conductor extended in the canal, I will just add another observation."—Then he goes on to describe how a discharge of lightning fused a copper wire conductor, and assumes that had the end of this wire been immersed in water, the water would have been decomposed solely into hydrogen or oxygen, according to the positive or negative condition of the extremity of the wire connected with the water.

In a note to paragraph 207, Mr. Wilde quotes Faraday's *Experimental Researches* to prove that electricity of tension passing into water decomposes it solely into oxygen or hydrogen. His whole argument, as set forth in paragraphs 206, 207, and especially 208, falls to the ground, if the decomposition is not of this character, or if both gases are evolved simultaneously at one pole. Yet, on referring to Faraday's paper, we find that no such conclusion is warranted. Faraday describes a well-known experiment of Wollaston's, in which oxygen and hydrogen, mixed, were evolved from each pole. In his comments, Faraday writes as if he foresaw the use which Mr. Wilde would make of his name, and answers prophetically—"that the experiment should never be quoted as proving true electro-chemical decomposition is sufficiently evident, from the circumstance, that the law which regulates the transference and final place of the evolved bodies has no influence here. The water is decomposed at both poles independently of each other, and the oxygen and hydrogen evolved at the wires are the elements of the water existing the instant before in those places. That the poles, or rather points, have no mutual decomposing dependence, may be shown by substituting a wire, or the finger, for one of them, a change which does not at all interfere with the other,

* Experimental Researches in Magnetism and Electricity. Second series. By H. Wilde, Esq. § 4, on the Transmutable Nature of Water. *Philosophical Magazine*, Ser. 4, vol. 36, p. 106.

though it stops all action at the changed pole."—(*Phil. Trans.*, Jan. 1833, par. 328.) Extending Wollaston's experiment, Faraday subsequently found that, with frictional electricity, electro-chemical decomposition does not depend upon the simultaneous action of two metallic poles, since a single pole might be used, decomposition would ensue, and one or other of the elements become liberated and pass to the pole, according as it was positive or negative. His philosophical mind did not, however, lead him to jump to the startling conclusion to which a similar observation has beguiled Mr. Wilde, for Faraday goes on to say (*loc. cit.* par. 461)—"In considering the course taken by, and the final arrangement of, the other element, I had little doubt that I should find it had receded towards the other extremity, and that the air itself had acted as a pole, an expectation which was fully confirmed in the following manner."

Mr. Wilde complacently proceeds—"That the evolution of electrolytic oxygen and hydrogen from water is an operation of transmutation, and not one of decomposition, was further shown by the converse experiment of the reconversion of oxygen and hydrogen alone into water." This converse experiment being simply the conversion of some of the above-described arrangements into a gas battery.

An author who admires Faraday sufficiently to copy the form of the *Experimental Researches in Electricity* in its arrangement of headings, sections, numbered paragraphs, repeated cross references, and painstaking minuteness in describing the details of every experiment, should remember also that this Great Philosopher said that the most difficult thing for a student of physical science was to conduct a satisfactory experiment; he should not quote authorities to prove one view when they really prove the opposite; nor should he adduce a very early suggestion of Davy in favour of the idea that water might be the ponderable basis of both oxygen and hydrogen, when Davy himself, as the result of an elaborate research carried out in order to ascertain the facts of the case, came to the conclusion that this, his first inchoate idea, was untenable. Even if the chronological order of discoveries bearing upon its nature had been inverted, Mr. Wilde ought to know that the recognised view of the atomic composition of water stands upon too firm a basis of chemical facts to be "summarily rejected at the present day," as he asserts it would be. But *Le style c'est l'homme*. It has cost us much painstaking to extract the author's meaning, so ponderous and obscure is his style, so lame and impotent his conclusions. Ungainly sentences of fourteen, sixteen, and even twenty-one lines of close type, undivided except by commas, constitute an onerous tax on the brain of scientific students. But the style fitly represents the perverse reasoning and confusion of thought which pervades this odd paper.

ON THE COMBUSTION OF HYDROGEN AND CARBONIC OXIDE IN OXY- GEN UNDER GREAT PRESSURE.

BY E. FRANKLAND, PH.D., F.R.S.,
PROFESSOR OF CHEMISTRY IN THE ROYAL INSTITUTION, AND IN THE ROYAL
SCHOOL OF MINES.*

In a former communication to the Royal Society,† I described some researches on the effect of a diminution of pressure on some of the phenomena of combustion,

and deduced therefrom the law that the diminution in illuminating-power is directly proportional to the diminution in atmospheric pressure.

Further experiments, made more than a year ago, on the nature of the luminous agent in a coal-gas flame,* led me to doubt the correctness of the commonly received theory, first propounded by Sir Humphry Davy,† that the light of a gas flame, and of luminous flames in general, is due to the presence of solid particles. In reference to gas and candle-flames, it is now well known that the fuliginous matter produced when a piece of wire-gauze is depressed upon such flames, and the sooty deposit which coats a piece of white porcelain placed in a similar position, are not pure carbon, but contain hydrogen, which is only completely got rid of by prolonged exposure to a white heat in an atmosphere of chlorine. On pursuing the subject further, I found that there are many flames possessing a high degree of luminosity which cannot possibly contain solid particles. Thus the flame of metallic arsenic burning in oxygen emits a remarkably intense white light; and as metallic arsenic volatilises at 180° C., and its product of combustion (arsenious anhydride) at 218° C., whilst the temperature of incandescence of solids is at least 500° C., it is obviously impossible here to assume the presence of ignited solid particles in the flame. Again, if carbonic disulphide vapour be made to burn in oxygen, or oxygen in carbonic disulphide vapour, an almost insupportably brilliant light is the result. Now, fuliginous matter is never present in any part of this flame, and the boiling point of sulphur (440° C.) is below the temperature of incandescence, so that the assumption of solid particles in the flame is here also inadmissible. If the last experiment be varied by the substitution of nitric oxide gas for oxygen, the result is still the same; and the dazzling light produced by the combustion of these compounds is also so rich in the more refrangible rays that it has been employed in taking instantaneous photographs, and for exhibiting the phenomena of fluorescence.

Many other similar cases of the production of brilliant light from incandescent, gaseous, or vaporious matter might be cited; but I will mention only one other. Amongst the chemical reactions celebrated for the production of dazzling light, there are few which surpass the active combustion of phosphorus in oxygen. Now phosphoric anhydride, the product of this combustion, is volatile at a red heat; and it is therefore manifestly impossible that this substance should exist in the solid form at the temperature of the phosphorus flame, which far transcends the melting-point of platinum. For these reasons, and for others stated in the lectures above quoted, I consider that incandescent particles of carbon are not the source of light in gas and candle-flames, but that the luminosity of these flames is due to radiations from dense but transparent hydrocarbon vapours. As a further generalisation from the experiment above mentioned, I was led to the conclusion that dense gases and vapours become luminous at much lower temperatures than æriiform fluids of comparatively low specific gravity, and that this result is to a great extent, if not altogether, independent of the nature of the gas or vapour, inasmuch as I found that gases of low density, which are not luminous at a given temperature when burnt under common atmospheric pressure, become so when they are simultaneously compressed. Thus mix-

* Read before the Royal Society, June 11, 1868.

† *Phil. Trans.* vol. cll., p. 629 (1861).

* Lectures on Coal Gas, delivered at the Royal Institution, in March, 1867. *Journal of Gas Lighting.*

† *Phil. Trans.* for 1817, p. 75.

tures of hydrogen and carbonic oxide, with oxygen, emit but little light when they are burnt or exploded in free air, but exhibit intense luminosity when exploded in closed glass vessels, so as to prevent their expansion at the moment of combustion.

I have recently extended these experiments to the combustion of jets of hydrogen and carbonic oxide in oxygen under a pressure gradually increasing to twenty atmospheres. These experiments were conducted in a strong iron vessel, furnished with a thick plate of glass of sufficient size to permit of the optical examination of the flame. The results are so remarkable that, although still far from being complete, I venture to communicate them to the Royal Society before the close of the session. The appearance of a jet of hydrogen burning in oxygen under the ordinary atmospheric pressure is too well known to need description. On increasing the pressure to two atmospheres, the previously feeble luminosity is very visibly augmented, whilst at ten atmospheres' pressure the light admitted by a jet about 1 inch long is amply sufficient to enable the observer to read a newspaper at a distance of 2 feet from the flame, and this without any reflecting surface behind the flame. Examined by the spectro-scope, the spectrum of this flame is bright and perfectly continuous from red to violet.

With a higher initial luminosity, the flame of carbonic oxide in oxygen becomes much more luminous at a pressure of ten atmospheres than a flame of hydrogen of the same size and burning under the same pressure. The spectrum of carbonic oxide burning in air is well known to be continuous; burnt in oxygen under a pressure of fourteen atmospheres, the spectrum of the flame is very brilliant, and perfectly continuous.

If it be true that dense gases emit more light than rare ones when ignited, the passage of the electric spark through different gases ought to produce an amount of light varying with the density of the gas; and this is in fact the case, for electric sparks passed as nearly as possible under similar conditions through hydrogen, oxygen, chlorine, and sulphurous anhydride emit light, the intensity of which is very slight in the case of hydrogen, considerable in that of oxygen, and very great in the case of chlorine and sulphurous anhydride. When liquefied sulphurous anhydride is sealed up in a strong tube furnished with platinum wires, and the temperature then allowed to rise until the internal pressure amounts to three or four atmospheres, the passage of induction-sparks through the enclosed gas is attended with very brilliant flashes of light. Further, if a stream of induction-sparks be passed through air confined in a glass tube connected with a condensing syringe, and the pressure of the air be gradually augmented to two or three atmospheres, a very marked increase in the luminosity of the sparks is observed, whilst on allowing the condensed air to escape, the same phenomena are observed in the reversed order.

The electric arc from fifty cells of Grove's battery is incomparably more brilliant when mercury vapour, instead of atmospheric air, is interposed in the path of the discharge between the carbon points. The gases and vapours just mentioned have the following relative densities:—

Hydrogen.....	1.0
Air.....	14.5
Oxygen.....	16.0
Sulphurous anhydride.....	32.0
Chlorine.....	35.5
Mercury.....	100.0

It is obvious that the above results have a very direct bearing upon the views now generally held regarding the constitution of the sun, stars, and nebulae; but I refrain from making any such application of them until I have the honour of laying before the Royal Society a complete account of these experiments.

ON A METHOD OF
ESTIMATING TARTARIC AND MALIC ACIDS
BY MEANS OF
IRON, ALUMINIUM, MANGANESE, &c.,
AND RECIPROCALLY.

BY M. JUETTE.

Of all acids, tartaric and malic acids alone possess the known property of rendering iron, aluminium, manganese, &c., soluble in alkaline liquids.

Peroxide of iron in acid solution, not containing either tartaric or malic acid, is precipitated as soon as the liquid is neutralised by ammonia. If, on the contrary, iron and tartaric acid be mixed in determinate proportions, or if the tartaric acid be in excess, there will be produced, after saturation with ammonia, a tartaroferric ammoniacal composition of a fine red colour, soluble in acid or alkaline liquids provided they do not contain any of the oxides of the alkaline-earthly metals. The study of this phenomenon has led to a method of estimating either tartaric and malic acids with a standard solution of iron or aluminium, or of these same metals with a standard solution of crystallised tartaric acid. A given weight of pure iron is dissolved in nitric acid, which is then diluted with distilled water to form a standard liquid containing 0.001 or 0.002 of iron. If to a solution of 100 milligrammes of iron, 45.5 milligrammes or any larger quantity of tartaric acid be added, and also one or two cubic centimetres of common ammonia to render the liquid decidedly alkaline, the product will be, after vigorous stirring, a red liquid which is at first thick, but which, when left to itself, becomes and remains limpid. If, on the contrary, to 100 milligrammes of iron be added 45 milligrammes or more of tartaric acid, and then an excess of ammonia, &c., the liquid, at first thick, deposits the characteristic precipitate of peroxide of iron. The soluble compound produced by a proportion of tartaric acid equal to or exceeding 45.5-100 is permanent in the presence of acids, alkalis, and alkaline carbonates, provided they be exempt from lime, and also in the presence of ammoniacal salts, alcohol, ether, &c. If the compound be heated to ebullition the iron is almost entirely precipitated; this may also be done by adding to the liquid some hours afterwards ordinary water containing calcareous salts.

In practice, 0.455 grammes of the substance to be assayed are dissolved in acidulated water, which is then diluted with common water to form a determinate volume, such as for instance 100 cubic centimetres; 10 cubic centimetres are deducted, and, according as the matter contains 1, 2, 3, . . . n hundredths of tartaric acid 1, 2, 3, . . . n milligrammes of iron may be added, which will remain dissolved. Thus, in a simple manner, by two trials two different results are obtained, namely,

With n milligrammes of iron.....limpid solution.
" ($n \times 1$) " "precipitate.

n is the number of hundredths of tartaric acid contained in the substance.

The estimation of tartaric acid in crystallised bitartrates and neutral tartrates gives to nearly 1-100 the proportion of tartaric acid indicated by the formula.

I was led to this method of direct estimation of tartaric acid by the necessity of estimating the value of the artificial tartrates of lime produced by the treatment employed upon the residue of the grape, and upon the weak vinegars from the distilleries, by my learned friend Dr. E. de Poutevès and myself during the last two years. The plaster residues of the south yield an average of 60 kilogrammes of rough tartrate, containing from 21 to 25 per 100, that is to say from 12 to 15 kilogrammes of tartaric acid. The tartaric acid from wine submitted to distillation is completely lost and mixed with the vinegar, from whence we obtain more than 5-10ths of the rough product sufficiently pure to undergo the ordinary process of extracting the acid.

In operating on wine or cider, a quantity a hundred times greater is used for each trial by measuring 45.5 cubic centimetres, diluting the volume to 100 cubic centimetres, and deducting ten for each trial. Thus the number of 10-000, or the number of decigrammes of tartaric acid per litre, is obtained.

It is unnecessary to pay any attention to the colouring matter of red wines; the results are clearer if the lime has been precipitated. This preliminary operation is necessary in the analysis of cider. Should tartaric and malic acid exist together in wine or cider, the test will allow of their being estimated together as tartaric acid. This process permits the resolution of physiological enquiries relative to the variable quantity of tartaric acid found in the grape during maturation, and in wine manufactured at different ages, and also in diseases of which such variations are the symptoms. In order to reverse the operation, the iron is estimated in percentages by means of a standard solution of tartaric acid. 100 milligrammes will render 0.2197 grammes soluble. 2.197 grammes of the material are dissolved and the liquid diluted to 100 cubic centimetres; 10 are removed and the smallest number, n , of milligrammes of acid capable of dissolving the iron is sought for. This method when applied to crystallised sulphate of iron easily gives results within one per cent. Lastly, this process is applicable to all metals which, like iron, aluminium, manganese, chromium, &c., possess the property of insolubility in ammoniacal liquids except in the presence of determinate quantities of tartaric or malic acid.—*Comptes Rendus*, lxvi., 417.

CONTRIBUTIONS TO OUR KNOWLEDGE OF PERSULPHIDE OF HYDROGEN.

BY DR. A. W. HOFMANN, F.R.S.

PERSULPHIDE of hydrogen, first observed by Scheele, was afterwards examined by Berthollet; but our knowledge of this remarkable body is almost entirely due to Thenard,* who soon after the discovery of peroxide of hydrogen, submitted the persulphide to a detailed study. The composition of this body is, however, doubtful. Thenard only stated that the specimens examined by him contained sulphur in varying proportions, but always greater than what ought to exist in a sulpho-compound corresponding to a peroxide of hydrogen.

If, therefore, some authors allow themselves to express the composition of persulphide of hydrogen by the formula—

HS_2 ,

either with or without a note of interrogation, they are going beyond what experience would warrant.

Certain circumstances have recently drawn chemists' attention anew to persulphide of hydrogen.

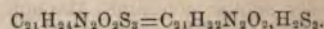
Amongst the novelties in technical chemistry which were made known at the Exhibition of 1867, none perhaps excited so much interest as those which by the most diverse methods sought to bring back for industrial purposes the masses of sulphur locked up in the mountains of soda residues. Chemists have especially admired the processes by which both M. Schaffnert or MM. P. W. Hofmann and P. Buquet succeeded in solving this problem.

In certain stages of the reactions on which these processes are founded, persulphide of hydrogen is often formed in large quantities, and quite recently, on visiting the manufactory at Dieuze, where sulphur is regenerated on an immense scale, I was able to procure several kilogrammes of this remarkable sulpho-compound.

This fortunate circumstance, by placing at my disposal considerable quantities of persulphide of hydrogen, allows me to throw some light on the composition of this product.

When a cold saturated solution of strychnine in strong alcohol is mixed with an alcoholic solution of sulphide of ammonium containing an excess of sulphur, brilliant crystalline flakes shortly appear in the liquid, and twelve hours later the sides of the vessel are covered with beautiful needles of an orange colour, which sometimes attain several centimetres in length. In order to obtain them in the state of perfect purity it is sufficient, after having decanted the mother liquor, to wash them with cold alcohol. These crystals are completely insoluble in water, alcohol, ether, and sulphide of carbon; indeed, I have not succeeded in finding a solvent from which they can be crystallised.

Analysis of this compound led me to the following formula:—



The crystals are therefore a combination of one molecule of strychnine with one molecule of persulphide of hydrogen, the composition of which must therefore be expressed by the formula—



Indeed, the compound splits up according to the above formula. If the orange crystals are washed with concentrated sulphuric acid, they gradually decolourise with formation of sulphate of strychnine, which dissolves, whilst persulphide of hydrogen separates in the form of a colourless transparent oil. The drops of oil will keep for some time, but they gradually decompose into hydrosulphuric acid and sulphur.

The examination of this perfectly definite compound of strychnine and persulphide of hydrogen, which may be preserved for months without alteration, leaves little doubt as to the existence of a persulphide of hydrogen—



which is therefore a sesquisulphide. It is, however, conceivable that there may exist other persulphides of a different composition.

The formation of the compound of strychnine just described, and which I have frequently made with the same success, led me to submit other alkaloids to an analogous treatment. Thus, I have examined the action of an alcoholic solution of sulphide of ammonium on quinine, cinchonine, brucine, and other vegetable

* THENARD, *Ann. de Chem. et de Phys.*, xlviii., 79.

bases, but in no case have I observed the appearance of phenomena similar to those seen when operating with strychnine.

The compound of strychnine with persulphide of hydrogen is remarkable for its insolubility. An alcoholic solution containing 2.03 grammes of strychnine being mixed with an alcoholic solution of sulphide of ammonium deposited, after twelve hours, 2.287 grammes of orange crystals, that is to say 87.2 per cent of the theoretical quantity. It remains to be seen whether this property of strychnine of forming so insoluble a compound with persulphide of hydrogen may not be utilised in the preparation of this alkaloid; and even in certain cases for its separation of substances with which it may be mixed.—*Comptes Rendus*.

ON SOME OF THE CONSTITUENTS OF COAL GAS.*

A LECTURE BY DR. ODLING, F.R.S., F.C.S., &C,

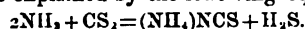
BEFORE THE BRITISH ASSOCIATION OF GAS MANAGERS,
TUESDAY, JUNE 2.

(Concluded from Am. Repr., Sept. 1868, p. 134.)

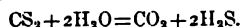
DISULPHIDE of carbon is a compound of great chemical interest, and I will now endeavour to illustrate to you some of its most striking properties. In the first place, it is a readily combustible substance—its carbon burning into carbonic acid gas, CO_2 , and its sulphur into sulphurous acid gas, SO_2 ; but when burned with a deficient supply of air, a good deal of its sulphur escapes combustion, and separates as a deposit of yellow smoke. By warming a little disulphide of carbon in this flask I get an abundant supply of the vapour, which you now see burning with a fine blue flame, not unlike that of carbonic oxide. The flame is of very considerable brilliancy; and a piece of iron wire or watch spring burns readily in it, with vivid scintillations and formation of sulphide of iron. Here, then, we have an illustration of the inflammability of disulphide of carbon in the state of vapour; and before calling your attention to the facility with which it assumes the state of vapour, I will just refer to the brilliancy of its combustion, both in oxygen and in the gas known as nitric oxide. With oxygen, however, the experiment is a dangerous one, from the violence of the explosion. In this jar of nitric oxide gas, then, I introduce a small quantity of disulphide of carbon, and, after shaking up the jar, apply a light to its mouth, when you will observe a large descending body of flame of surpassing intensity. This flame is very rich in chemical rays, and although lasting for scarcely an instant, is nevertheless applicable to the purposes of photography as a substitute for daylight. I will next give you an illustration of the facility with which the disulphide vapourises. At one end of this long shallow tray I place a piece of sponge wetted with disulphide of carbon. I now bring a lighted taper to the other end of the tray, at a distance of 3 or 4 feet from the sponge, and you observe that the vapour with which the tray is filled immediately takes fire; and I thus set fire to the sponge at a distance from it of several feet. The vapour of disulphide of carbon is very heavy—nearly three times as heavy as air. I have here a bottle of disulphide of carbon vapour, and here a succession of empty glasses. I pour the vapour from the bottle into a glass, from the first glass into a second, from

the second into a third, and from the third into a fourth, and you see that in that fourth glass there is sufficient disulphide of carbon vapour left to take fire upon my bringing a light to it. The extremely low inflaming point of disulphide of carbon vapour is another point of much interest. I have here a little olive oil in a test tube, which I heat over a lamp to the temperature of about 400° , although a lower temperature would suffice; and when I bring the extremity of the tube of hot oil near to the disulphide of carbon in this glass, you observe that it acts like a lighted match, and immediately inflames the vapour of the disulphide.

With regard to the chemical nature of disulphide of carbon, it is an anhydrous sulphur acid, comparable, as I have said, with anhydrous carbonic acid. It unites with basic sulphides, including sulphide of ammonium, just as carbonic acid unites with basic oxides, including aqueous ammonia. Thus sulphide of carbon vapour, CS_2 , is absorbed by sulphide of ammonium solution $(\text{NH}_4)_2\text{S}$, with production of sulphocarbonate of ammonium $(\text{NH}_4)_2\text{CS}_3$, corresponding to neutral carbonate of ammonium $(\text{NH}_4)_2\text{CO}_3$. When this sulphocarbonate of ammonium is exposed to the action of heat or of free ammonia, it loses sulphuretted hydrogen, and is converted first into a salt called the sulphocarbamate of ammonium $(\text{NH}_4)_2\text{MH}_2\text{CS}_2$, and eventually into the sulphocyanate $(\text{HN}_3)_2\text{NCS}$, which is a tolerably stable compound. This sulphocyanate is also the principal product of the reaction of disulphide of carbon with free ammonia, as explained by the following equation:—



With the fixed alkaline hydrates and sulphhydrates, sulphocarbonates also are formed, which are, like the ammonia salt, unstable, but, unlike it, do not change into sulphocyanate. Availing ourselves of these reactions, disulphide of carbon may be removed from small quantities of gas by passing the gas through aqueous ammonia, or potash, or solution of sulphide of ammonium (gas liquor), or of sulphide of potassium or calcium (gas lime). But, owing to the insolubility of the disulphide in water, and its small proportion in the gas, its complete removal on the large scale by these means is quite impracticable, the impure gas having to remain for so long a time in contact with so large a surface of the absorbent, as I explained to you when treating of ammonia. The disulphide being soluble in alcohol, better results on a small scale are obtained by passing the gas through an alcoholic instead of a watery solution of potash. In this case the salt produced is not the simple sulphocarbonate of potassium, K_2CS_3 , analogous to the carbonate, K_2CO_3 ; but it is the ethyloxysulphocarbonate, better known as the xanthate of potassium, $\text{K}(\text{C}_2\text{H}_5)_2\text{CS}_2\text{O}$, or KEtCS_2O . The solution of this salt gives a yellow precipitate with sulphate of copper, and a black precipitate with acetate of lead, especially on gentle warming. Another chemical property of disulphide of carbon is its reaction at a moderate heat with water, whether in the form of steam, or of a definite hydrate, as that of calcium (slaked lime). At about 400° a reaction of this kind takes place, though only imperfectly, with production of sulphuretted hydrogen and carbonic acid—



As regards the products of the complete combustion of disulphide of carbon, I have already said that they are the carbonic and sulphurous acids. Now, sulphurous acid, which, in a greatly diluted state, is a very harmless substance, altogether different from sulphuric

* Reprinted, by permission, from the *Journal of Gas Lighting*.

acid, is a constant product of the combustion of coal gas, and is derived from the presence in the gas partly of disulphide of carbon, and partly, it would seem, of other sulphur compounds of a similar nature. The proper mode of estimating the proportion of the sulphur existing in coal gas, in these different forms, is now, as you know, a subject of controversy. One party maintains that we ought only to estimate the amount of sulphur which, during the combustion of the gas from an ordinary burner, is converted into sulphurous acid—this sulphurous acid being regarded with great, though unwarrantable, alarm, from its possible conversion into sulphuric acid, which is alarmingly designated oil of vitriol. Now, if this estimation could really be made, it would, I am inclined to think, be perfectly sufficient; but as a matter of fact, it is quite impracticable to estimate the amount of sulphurous acid produced by the combustion of gas—burning the gas as it is ordinarily burned for purposes of illumination. When it is attempted to measure the amount of sulphurous acid produced by the combustion of gas, the gas is necessarily burned in a special manner, usually at the rate of about three-quarters of a foot an hour, with a non-luminous flame, and under conditions which cannot be, or at any rate have not been, specially defined.

Another party, with which I confess that I am disposed to agree, says—"Take the bull by the horns, admit the worst, estimate by any efficient means the total quantity of sulphur contained in the gas, and declare it." Now, it is quite certain that if we take sufficient time and pains, we can estimate the absolute amount of sulphur existing in gas with reasonable certainty. But the Act of Parliament, having reference to the amount of sulphur indicated by the sulphurous acid formed in the combustion of the gas, as I have previously referred to, declares that the amount of sulphur existing in the gas in every form shall not exceed 20 grains in 100 feet. But this provision of the act is habitually and necessarily set at defiance. Not unfrequently the gas supplied in London furnishes, by its combustion, a quantity of sulphurous acid equivalent to slightly more than 20 grains in 100 cubic feet; and I think I may say that it almost invariably contains an absolute quantity of sulphur exceeding 20 grains in 100 feet, which, so far as I know, it is quite impracticable on the large scale to remove. What is the average amount of actual sulphur contained in London gas I cannot tell you, but I believe it is nearer 30 than 20 grains in 100 feet. I might here direct your attention to the very ingenious instrument devised by Mr. Valentin for making an absolute determination of the sulphur contained in gas, which gives much higher results than are furnished by Mr. Lewis Thompson's and Dr. Letheby's instruments. Mr. Valentin has kindly lent me the instrument for exhibition here this evening, and, being present, will, I am sure, be happy, at the conclusion of my lecture, to explain its construction to any gentlemen interested in the subject.

So far, then, I am a little at issue with gas managers in being disposed to admit that ordinary coal gas contains a greater amount of sulphur in some form or other than they are willing to allow, and than the letter, though not the spirit, of the Act of Parliament permits; for the Act was framed upon the results furnished by an incomplete combustion of the gas and condensation of the products. But, on the other hand, I am altogether at issue with the public, when they maintain that the sulphur of gas produces, by its combustion, oil of vitriol, or that the amount of sulphur ordinarily contained in gas is of any consequence whatever; and a

little consideration will, I think, satisfy you of the soundness of this position. We will assume that coal gas contains, not 20, but 40 grains of sulphur in 100 feet—a quantity, at any rate, greatly exceeding the reality. Now, making another extravagant assumption, that the whole of these 40 grains of sulphur would be completely burnt—and in reality they would be burnt very incompletely—they would furnish by their combustion 80 grains of sulphurous acid gas. This quantity of the produced sulphurous acid would occupy at ordinary temperatures about 1-15th part of a cubic foot, and since 100 cubic feet of our coal gas give 1-15th of a cubic foot of sulphurous acid, 1500 cubic feet of coal gas would be required to furnish 1 cubic foot of the acid, even upon the extravagant assumptions we have purposely made. But the combustion of 1500 feet of coal gas would produce something besides sulphurous acid. It would produce at least 1000 cubic feet of carbonic acid; and, in addition to its dilution by other gases and vapours, we should have our sulphurous acid diluted by 1000 times its volume of carbonic acid. Now, if we can get at the proportion of carbonic acid in the atmosphere of a room highly illuminated with gas, and take the 1000th part of that proportion, we shall be able to form some notion of the amount of sulphurous acid present. You will remember that the amount of carbonic acid furnished by the breath of one individual is equal to that furnished by two 3-foot gas burners, and that the maximum amount of carbonic acid found in the atmosphere of a crowded theatre was '32 per cent. Now, if, in addition to our previous unreasonable suppositions, we further suppose that an atmosphere contains '2 per cent of carbonic acid furnished by gas combustion, you will see that the whole matter becomes a *reductio ad absurdum*—that we might actually have one half-millionth part of sulphurous acid present in the air of a gas-lighted room.

But this sulphurous acid is not sulphuric acid, and can only be converted into sulphuric acid with very much pains and difficulty, as all who have tried the experiment of converting the sulphur of coal gas into sulphuric acid are painfully aware. When gas is burned in special apparatus, indeed, its constituent sulphur can be converted into sulphuric acid; but it is very difficult to do this. The probability is that of the sulphurous acid produced in ordinary combustion scarcely a particle gets converted into sulphuric acid—certainly not more than the ammonia ordinarily existing in the atmosphere can neutralise, so as to form sulphate of ammonia instead of sulphuric acid; and with this conclusion, gentlemen, I bring to an end what I have to say to you respecting those constituents of coal gas which do not contribute much to its illuminating power.

SEWAGE EXPERIMENTS AT LEICESTER.

A short time ago we gave a brief account of some sewage experiments which had been tried by Messrs. Sillar and Wigner. So much curiosity has been excited by this account, and letters from correspondents enquiring for further particulars are so numerous, that we have thought it best to reprint the following account from the *Times* of Tuesday last:—

Some important experiments in the purification of sewage have been made at Leicester during the past week, and, indeed, are hardly yet concluded. The operations commenced on Tuesday; the members of the Royal Rivers Commission, Sir William Denison

and Dr. Frankland (without Mr. John Chalmers Morton, who has not quite recovered from a slight accident), were present on Thursday, accompanied by the mayor and several members of the corporation of Leicester. Owing to unexpected difficulties which we shall presently explain, a prolongation of the trial was decided on, Dr. Frankland's assistant, Mr. Thorp, being appointed to watch the proceedings and take samples for analysis.

The object has been to put a new invention, the nature of which will be easily understood, to a practical test. The manurial matters in town sewage exist in a state of such attenuated solution that the weak liquid is valued at only twopence or a little more per ton; mere cost of conveyance, therefore, precludes its application to any but low-lying lands, and, as it cannot be stored for use except in certain seasons, it cannot be fully utilised except by some special system of husbandry capable of consuming one invariable quantity day by day throughout summer and winter. Hence, what a striking advantage it would be if we could separate the valuable constituents from the extremely diluted liquid, fixing them in a concentrated, dry, easily transportable manure worth several sovereigns per ton, that could be stored for use in any season and applied in any situation! Of the many plans proposed for accomplishing this feat, some have managed to separate the whole of the insoluble or sedimentary matter, and even a small proportion of the soluble constituents; but hitherto no chemical or mechanical device has succeeded in precipitating in a solid form the most valuable ingredients held in excessive dilution in the sewage. Everybody seemed to have agreed that the only feasible mode of utilising sewage is by surface irrigation. Inventors, however, are a class of people seldom found to relinquish a problem as hopeless; and little more than a month ago a new process for accomplishing the desired result was patented by Mr. Robert George Sillar (of the firm of W. C. Sillar and Co., bullion brokers, Cornhill), and Mr. George W. Wigner, analytical chemist, Grove-lane, Camberwell. The origin of inventions is often very curious; the present one is said to have been suggested, strangely enough, by some of the purifications enjoined upon the ancient Hebrews, "the ashes of a heifer" pointing out animal charcoal, and blood poured upon the ground prompting a use of blood and of clay. The inventors, therefore, mixed these three substances,—animal charcoal, blood, and clay,—adding alum and three other chemicals which are at present secret, but affirmed to be cheap and commercially obtainable in any quantity. Laboratory experiments showed that this "A B C compound," as it was called, had the power of precipitating nearly all the manurial constituents of sewer water, the whole settling in a flocculent mass at the bottom of the vessel in the course of a few minutes. The water was left almost pure, and the residuum when dried required only simple treatment by an acid to render soluble certain of the constituents for the use of plants. Of course, until further inquiry is made, and until the Rivers Commission authorise a publication of their own analysis, the inventors are responsible for these statements.

On the 16th of June a practical trial was made at Tottenham, where the Local Board of Health, being restrained by an injunction from pouring their sewage unpurified into the river Lea, are endeavouring to ascertain which is the most efficient and least expensive mode of purification. As reported in "*Engineering*"

of July 3, a tank was filled with 5,000 gallons of very black sewage, a quantity of the A B C compound in solution was pumped in, and the water settled clear in twenty minutes, being so clarified and deodorised as to be free from smell and nearly tasteless. A large tank was gradually filled with 36,000 gallons of sewage, admitted at the rate of about 1,000 gallons per minute, the solution running in at the same time, and in twenty minutes after the tank was full the precipitation had been effected and the water was clear. According to the inventor's analysis the water retained only one-eighth of the organic or dangerous impurities; and no less than 85 per cent of the ammonia and all the phosphoric acid (the two most valuable constituents) were removed from the sewage and fixed in the solid residuum. The 36,000 gallons of sewage yielded 8 cwt. of air-dried manure containing 20 per cent of organic matter, 2.37 per cent of ammonia, and 5.33 per cent of phosphoric acid. Mr. Wigner valued it at £2 3s. per ton; but it contained 68.5 per cent of silica, alumina, and various salts, and nearly half of this has been now removed by an easy process, leaving the manure worth so much more. The cost of the A B C compound in this experiment is stated to have been only 7s. 2d.; while the manurial product was valued at about 17s.

The Leicester trial is on a much larger scale, the mayor and corporation, at the request of the Rivers Commission, having placed their sewage works and machinery at the disposal of the inventors for several days. The drainage of this, probably the very cleanest and best kept manufacturing city of 90,000 inhabitants, is discharged into the river Soar at the rate of more than 4,000,000 gallons per diem, being lifted by two pumping-engines of twenty-two horse power each, at the Abbey-lane sewage works, about a mile north of the town. Here a company expended a great many thousands of pounds in carrying out Wicksteed's milk of lime deodorising process; finally handing over the present extensive buildings, tanks, machinery, outdoor drying vats, &c., to the Leicester corporation, who now use them. Milk of lime is mixed with the sewage, which is thus partially deodorised before flowing into the river, while the offensive black sediment, drawn from the beds of the settling tanks by horizontal screws and elevators, is drained and air-dried in embanked compartments, and then sold (to a very limited extent) to farmers at 1s. per cart-load.

Visiting the works on Friday we found the lime process going on in one-half of the establishment, while the other was devoted to Messrs. Sillar and Wigner—that is to say, one of the pumping engines and two of the great tanks were employed as usual, while the other engine and two tanks, holding 417,000 gallons at once, were occupied in the new process. The engine works two pumps, the large one delivering about 100,000 gallons of sewage per hour into a first or receiving tank, the smaller pump at the same time injecting into the sewage about 1000 gallons of the chemical solution, this entering the side of the huge pipe which leads from the sewage pump to the receiving tank. The agitation in the first or receiving tank causes a partial mixture; but a complete churning and intimate union are effected by the sewage passing through a number of small apertures into cells, in each of which revolves a stirrer, and thence out of the cells into two very spacious settling tanks. An artificial dam of bags of earth had been constructed to divide the receiving tank; this was frequently breached by the wash of the in-flowing sewage, thus mixing a portion of the lime-sewage with

the other, and so vitiating the experiment, and fair specimen samples could not be taken until a sufficient time had elapsed after a repair of the dam. The chambers which supplied the smaller pumps had also been divided, so that one pump could be fed with milk of lime and the other with the A B C solution, and, unfortunately, a leakage made some difficulty here. Worse than this, it was found that the dry granulated clay used in the compound (which was all mixed on the spot) contained some small gravel, and several times this got into the pump valve and deranged the action of the pump, stopping the injection of the solution, while the pumping of the sewage continued. Long delays were occasioned; and of course no fair sample of the effluent water discharged from the tank into the river could be taken until the charge of sewage in the tanks had been completely renewed. Hence the trial was to be continued until Monday, Aug. 3rd. On Friday we did observe that the water passing over at the exit end of the great tank was clearer than that from the lime process, and that any odour from it was less perceptible. We found that the sediment from the new process had little smell, while that from the lime process was horribly offensive. We saw test-glasses full of the sewage precipitated in two or three minutes and made perfectly clear and sweet. We were informed that on the previous days, when the pump and the artificial tank walls were in order, the following average, but not corrected, results were obtained:—An imperial gallon of the sewage as it comes from the main culvert contains 130.2 grains of inorganic matter and 58.8 grains of organic matter; total, 189 grains per gallon. After the lime process the purified sewage-water contains 89.7 grains of inorganic and 42.7 grains of organic matter; total, 132.4 grains per gallon. But after the new process the purified sewer-water contains 43.3 grains of inorganic and 14.2 grains of organic matter; total, only 57.5 grains per gallon. We believe that London drinking water commonly contains 8½ grains of organic matter per imperial gallon; that is more than half the quantity left in this purified sewage, which must, therefore, be quite innocuous. The following is an approximate analysis of the air-dried residuum or manure which the new process has removed from the sewage at Leicester:—

Water.....	8 per cent.
Organic matter.....	36 "
Phosphoric acid.....	4 "
Sulphate of lime.....	1 "
Alumina.....	9 "
Silica.....	39 "
Iron, loss, &c.....	3 "
	100
Ammonia.....	3½ "

This is considerably richer in ammonia than the Tottenham manure, which was valued at £2 3s. per ton; in fact, reckoning ammonia at £60 per ton, and the phosphoric acid (from its equivalent in phosphate of lime) at £50 per ton, the Leicester sewage manure, by the above analysis, is worth £4 per ton. These analyses were made by Mr. Wigner, the inventor, and are open to correction, or to exposure from the official analyses that will be made by Dr. Frankland.

We are told that the actual cost of the A B C compound used at Leicester has amounted to 8s. 7d. for each 100,000 gallons of sewage treated, whence the cost of materials for purifying the whole 4,000,000 gallons of sewage daily furnished by the town would be

£17 3s. The alum, the clay, the animal charcoal, and the three unknown chemicals are all procurable (so we learn) to any extent; and the blood used is only one pint to each 20,000 gallons of sewage, so that the daily consumption for Leicester would be 25 gallons.

The manure left as a black semi-fluid mud at the bottom of the tanks has yet to be removed by the worm-screw and dredge-elevators, and its quantity ascertained. But if it be true that of 189 grains of ingredients in each gallon of sewage 57.5 grains go away in the clarified water, 121.5 grains from each gallon of sewage must either remain in the precipitated residuum, or be dissipated into the atmosphere. At Tottenham, 40,000 gallons of sewage are reported to have yielded 8 cwt. of dried manure; and at this rate the 4,000,000 gallons of Leicester sewage should give 40 tons of manure per day, worth (as we have valued above) about £4 per ton. A return in manure of £160 per day for an outlay of £17 3s. in chemicals must leave a margin for huge profit, after paying any conceivable working expenses, and the interest upon buildings and machinery necessary for conducting the process.

The Leicester experiments are not yet completed, but we have said enough to show the importance of the pending inquiry, whether this new invention really is a marvellous boon to the world, or whether the whole is an illusion or a sham.

ON THE PREPARATION OF IODIC ACID AND IODATE OF POTASSIUM.

BY PROFESSOR J. S. STAS.

Iodic Acid.—I prepare this acid by the action of pure iodine on normal nitric acid. To effect this I operate on four litres at a time of pure nitric acid, to which I add a tenth of its weight of iodine. The yield of iodic acid given by this method has been much exaggerated; the quantity produced only represents one quarter of the weight of the iodine employed. In order to remove with certainty the nitric acid which the iodic acid always contains, I dissolve in water the solid yellowish residue, obtained on evaporating to dryness the liquid resulting from the reaction of iodine on fuming nitric acid. The solution of this crude acid, when introduced into a vessel made of glass unattacked by acids, is evaporated to dryness; the whole residue is heated to 200°, and kept at this temperature to bring it to the state of iodic anhydride, and to remove with the water the last trace of nitric acid which it contains.

As the action of nitric acid on iodine took place in a large retort of ordinary glass, the iodic acid obtained contains traces of iodates of sodium and calcium, which I have not been able to remove.

I hoped to have been able to employ iodic acid in the determination of the atomic weight of iodine; with this object I prepared more than two kilogrammes of crystallised iodic acid by the action of boiling dilute sulphuric acid on iodate of barium; but, in spite of all precautions, I found it impossible to prepare in this manner either iodic acid or iodic anhydride free from barium, the greater part of which existed in the state of sulphate. After the efforts I made to remove the barium, I believe I may affirm that it is impossible to prepare pure iodic acid in this manner.

Iodate of Potassium.—Requiring large quantities of this salt, I tried many methods of preparing it. One furnished me with a product which was unaltered in the air. One consisted in transforming an aqueous

solution of hydrate of potash into iodide and iodate, by acting on it with purified iodine; the other was based upon the formation of iodate by the action of heat on a mixture of equal molecular weights of iodide and chlorate of potassium. This is how I prepared the iodate by the latter method. I mixed intimately the iodide and chlorate of potassium previously purified from foreign metals by means of a solution of sulphide of potassium. The well-dried mixture was introduced into retorts till they were about two-thirds full, and they were then placed in sand-baths. In the same bath I inserted rather deeply a small retort containing pure chlorate of potash. Each retort had connected with it a curved tube dipping into water. I elevated the temperature of the bath until the chlorate of potash in the small retort fused, and oxygen commenced to be evolved. When I had succeeded in well graduating the temperature so as not to overstep the temperature of decomposition of iodate of potash by heat (a temperature which is sensibly higher for iodate than for chlorate), I had completely transformed the iodide into iodate, and the chlorate into chloride, without any disengagement of oxygen.

To separate the iodate from the chloride I added to the mass after cooling cold water in sufficient quantity to disintegrate the mixture. The saline mass was then ground up and, after being introduced into a displacement apparatus, was lixivated with cold water until almost all the chloride was removed. The iodate was then submitted to three successive crystallisations. After each crystallisation, which was effected rapidly, the salt was submitted to a methodical washing. After the first crystallisation I was unable to discover a trace of chloride or iodide.

The iodate thus prepared remains indefinitely, without becoming yellow in the presence of air. This cannot be said of the salt which is obtained by attacking chlorate of potassium by means of iodine. Even when the ter-chloride of iodine which is always formed along with the iodate of potassium is decomposed by carbonate of potash, the salt so produced becomes very appreciably yellow in the air, even after it has undergone five successive crystallisations, each time followed by methodical washing. I have not been able to ascertain what is the substance which communicates to this iodate of potassium the property of becoming yellow, but the fact has always been found so.

NOTE ON

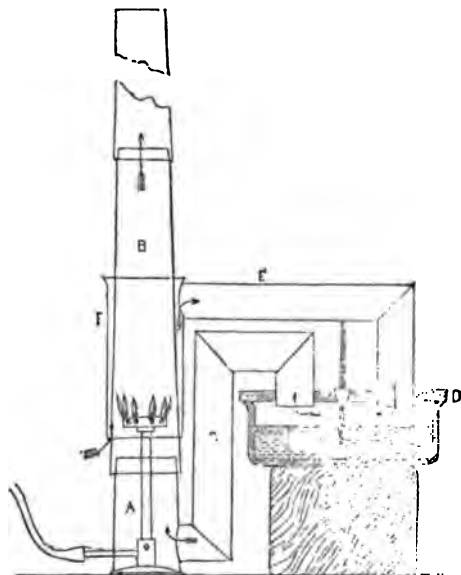
A SIMPLE APPARATUS FOR EVAPORATION AT LOW TEMPERATURES.

BY H. BASSETT.

HAVING had occasion to concentrate some solutions which would not bear the application of heat without partial decomposition, I was led to the construction of a little apparatus by means of which a comparatively large quantity of liquid may be evaporated in a short time at a temperature of 30° – 40° , and of which I give a description, believing that such an arrangement is likely to be found useful in many cases. The accompanying sketch is drawn to scale, one-sixth of the actual size:—

A is an ordinary Bunsen's burner fixed at the bottom of a sheet-iron chimney, B, rather more than two feet high, and closed at the bottom. The air necessary for combustion is supplied by the zinc tube, C, which fits into a hole in the slate cover, D, ground flat and fitting the evaporating dish closely. Into the other hole in

this cover is inserted the tube, E, of brazed copper, which is attached at the other end to the sheet-iron jacket, F, open at the bottom, but fitting tightly over the chimney at the top.



On lighting the gas, a strong current of air is established in the direction shown by the arrows, becomes heated by passing through the narrow space between the chimney and the jacket, F, and then sweeps over the surface of the liquid in the dish. Using the simple burner without the rose top, about a pint of water is evaporated (from a dish 6 inches in diameter) in 24 hours, the liquid never becoming heated above 30° . With the rose burner, which heats the chimney more strongly, about $1\frac{1}{2}$ pint in the same time, the temperature rising to 40° – 43° . The temperature of the current of air in the middle of the dish, above the liquid, is about 80° with the simple burner, and 120° with the rose.

NOTE ON

METALLIC BISMUTH, AND LIQUOR BISMUTHI ET AMMONIÆ CITRATIS.

BY DR. REDWOOD.

THE vicissitudes which have attended the commerce of bismuth for several years past have produced an unfavourable influence on the condition, in regard to purity, of some of the preparations of bismuth which are used in medicine. The price of the metal has undergone great fluctuations, ranging from 2s. 6d. to more than 20s. a pound; and, although the highest prices to which it has thus attained have been unprecedented in its previous history, the proportion of impure bismuth in the market has, at the same time, been unusually large. This unsatisfactory state of things appears to have arisen from a falling off in the supply of bismuth from those localities whence the best samples have been obtained, while new sources of supply, especially the Australian, have yielded the metal in a state in which its purification has been attended with considerable difficulty. Of the impurities most com-

monly occurring, arsenic, lead, copper, and silver are the most important. The bismuth may be freed from the first two of these, if present, with comparative ease, by a simple metallurgical operation, which consists in fusing it with nitre, as directed in the Pharmacopœia. This is the process usually adopted, and which answers best for removing the more oxidisable metals. It may be conveniently and successfully applied to quantities of the metal varying from four ounces to a pound by means of a gas furnace. The process, however, is insufficient for the removal of copper and silver; and it is with reference especially to the former of these that the principal difficulty is experienced in purifying some of the crude bismuth and bismuth ores of commerce. At the present time large quantities of Australian ore, rich in copper, are waiting the discovery of a method by which the bismuth it contains may be economically separated in a state of sufficient purity to admit of its being used for pharmaceutical purposes. When this question has been satisfactorily solved, there is every reason to believe that a great reduction in the price of the metal will take place. In the meantime we shall have much impure bismuth containing copper, which, although applicable for one of the purposes for which bismuth is required,—namely, the preparation of fusible metal,—is not well suited for the production of the compounds of bismuth used in medicine. Already the attention of metallurgists has been directed to the importance of providing a supply of purified bismuth for pharmacutists, and I am assured by houses extensively engaged in this branch of metallurgy that bismuth, free from arsenic, copper, or any material impurity, may now be obtained by those who are willing to pay the price for it.* As this purified bismuth is prepared by men accustomed to such operations from the ores which yield it most readily, it will be found the most economical and best course for those who require pure bismuth to buy the metal in the purified state, or otherwise it will be necessary, in applying the process of the Pharmacopœia, to use crude bismuth which is free from copper and silver.

With reference to *Liquor Bismuthi et Ammonie Citratis*, on which there has been some correspondence in the *Pharmaceutical Journal*, it may be stated that, if the conditions specified in the Pharmacopœia be fulfilled, that is to say, if the bismuth employed has been purified in the manner described, and if the purified metal, and also the solution prepared from it, answer to the tests as given, the latter will be free from arsenic, lead, copper, and silver. These are the impurities most likely to occur, and to the removal or detection of which the process of purification and the tests of the Pharmacopœia are directed; but if it were the object of a manufacturer to introduce other impurities which would elude detection by the tests as given, it would no doubt be possible to do so. I have recently met with two instances of such adulteration in subnitrate of bismuth, an account of which will be found in the following article.—*Pharmaceutical Journal*.

NOTE ON

A NEW ADULTERATION OF SUBNITRATE OF BISMUTH.

BY DR. REDWOOD.

I HAVE recently had occasion to examine two samples

* I have recently purchased such at 20s. a pound, the price of crude bismuth being at the same time 18s. a pound.

of subnitrate of bismuth, which have proved to be adulterated to a great extent, by the admixture of a substance which none of the tests usually applied would detect. These samples were sent for examination by wholesale druggists who had been led to suspect that they were not genuine, but who were greatly surprised to learn the extent and nature of the adulteration.

The first of the samples was sent me last May. It presented the usual appearance of the variety of subnitrate of bismuth generally met with in commerce in the form of powder, without any crystalline character. It dissolved in nitric acid with a slight evolution of carbonic acid gas, and this had caused it to be condemned as impure by a customer to whom it had been sent. The quantity of carbonate present in it was, however, extremely small. In other respects it answered to the Pharmacopœia tests, excepting that the solution in nitric acid gave a precipitate with nitrate of silver indicating the presence of oxychloride. This is so frequently met with in commercial subnitrate of bismuth that its detection would not have excited much surprise. Its presence is excused by manufacturers on the ground of its making the powder more suitable for some of the purposes to which it is applied, so that for such purposes the powder would be unsaleable if it did not contain any chloride. The chlorine having been estimated, and the equivalent quantity of oxychloride calculated therefrom, a further examination rendered it evident that there was something else present besides subnitrate of bismuth. The residue left after calcination was in excess of that which theory indicated; and this residue dissolved in nitric acid, mixed with dilute acetic acid, and precipitated with sulphuretted hydrogen, gave an amount of sulphide much below the theoretical quantity. The cause of these discrepancies was found in the filtrate, which yielded an abundant precipitate of phosphate of lime.

While I was engaged in this investigation, my attention was directed to a paper in the *Journal de Pharmacie et de Chimie* for last March, by Mr. Roussin, in which he alludes to the adulteration of subnitrate of bismuth with phosphate of lime, and describes a very simple method of detecting it. Mr. Roussin says that in one case he found as much as 28 per cent of phosphate of lime in a sample which presented the usual appearance and answered to the ordinary tests of subnitrate of bismuth. His process for its detection and estimation is as follows:—Dissolve equal quantities of the subnitrate and of tartaric acid in nitric acid slightly diluted with water, and add to this a strong solution of carbonate of potash until all effervescence has ceased, and the liquid is rendered strongly alkaline. "If the subnitrate of bismuth be pure the liquid will be clear, and will remain so even after it has been boiled, but if the sample of subnitrate submitted to the test should contain phosphate of lime, even to the extent of 1 or 2 per cent, this will form a white precipitate, which will not dissolve with long-continued boiling."

In applying this test, it is important to observe that the phosphate of lime, even when present in large quantity, is not precipitated in the first instance after the addition of the carbonate of potash, but its precipitation is immediately effected by boiling the solution. From the sample to which I have already referred I obtained in this way 11 per cent of phosphate of lime, and from another sample, which came from a different source, I have more recently obtained no less than 40 per cent of the same adulterant.

I have reason to believe that both these samples were of foreign manufacture.—*Pharmaceutical Journal*.

ON

IODIDE OF SILICIUM AND SILICI-ODOFORM.

BY M. C. FRIEDEL.

IN their very interesting article on the action of chlorhydric, bromhydric, and iodhydric acids upon silicium,* Messrs. Wöhler and Buff have described a crystalline substance of amaranthine colour, fusible, and soluble in sulphide of carbon, and considered by them to be iodhydrate of iodide of silicium. The study made by M. Ladenburg and myself of the action of chlorhydric acid on silicium showed that it was composed of two distinct bodies—chloride of silicium, SiCl_4 , and silicichloroform, SiHCl_3 ,—which would lead to the supposition that the iodised substance obtained by MM. Wöhler and Buff, consisted of a similar combination. This supposition I propose to verify.

The first experiment, in which the directions given in the above article were exactly followed, yielded a violet product manifestly containing free iodide. It was dissolved in sulphide of carbon and shaken up with metallic mercury; the solution was discoloured, and there remained, after the removal of the sulphide of carbon by distillation, a yellowish liquid, which on cooling became a crystalline mass, nearly white, and distilling at 285° . During distillation this product is coloured anew by the liberation of a certain quantity of iodine. The roseate crystalline substance thus obtained fumes in the air, decomposes in water, and dissolves in potash with evolution of hydrogen. This latter quality has been used to determine its nature. A bubble of thin glass, containing a given weight of the substance, was broken in a receiver inverted over mercury, and containing some cubic centimetres of potash. The quantity of hydrogen thus liberated is too small to agree with MM. Wöhler and Buff's, or any other accepted formula. Considering the product as a mixture of iodide of silicium, SiI_4 , and of the compound SiIII , analogous to silicichloroform, the proportion of the latter is perceived to be less than 8 per 100. The estimation of silicium confirms this conclusion, by giving figures similar to those which correspond with iodide of silicium.

The proportion of the hydrogenised compound being so small one could scarcely hope to separate it in such a way as to obtain it pure, retaining at the same time the purity of the iodide of silicium. In order to ascertain its qualities and composition the preferable mode is to prepare the iodide of silicium direct and in the absence of hydrogen. I have succeeded in causing the vapour of iodine to pass along with a current of completely desiccated carbonic acid, over crystallised silicium heated to redness. If the distillation of iodine is rapid, or if the silicium does not fill the tube, the product obtained is mixed with much iodine. This has led to the belief that iodide of silicium will not form under these conditions. If, on the other hand, caution be used, and a tube be procured of sufficient length filled with silicium, the crystals sublimed in the cool part of the tube will be white, and the liquid proceeding from their fusion yellowish. The product thus obtained, purified when necessary from iodine by solution in sulphide of carbon and agitation with mercury,

may be distilled in a current of carbonic acid without decomposition. Not so in the air, where its vapour on being heated catches fire, and burns with a red flame emitting much iodine vapour. The product distilled in carbonic acid is colourless or slightly yellowish. Its boiling point is 290° , and at 120.5° it solidifies and crystallises into a mass having a watered appearance (*moiré*) which is nearly always rose coloured, owing to a slight decomposition which takes place at the moment the tube is sealed. In those parts of the vessel which were merely moistened by the liquid, dendrites are formed analogous to those of chlorhydrate of ammonium. The crystalline form of iodide of silicium is cubic, and it may be obtained either by sublimation, evaporation, or refrigeration of its solution, in small regular octahedrons or groups of octahedrons, which are transparent, colourless, and incapable of action on polarised light.

Iodide of silicium decomposes in water with formation of silica and iodhydric acid, without liberation of hydrogen or precipitation of iodine. This reaction suffices to prove that its composition is analogous to that of the chloride, SiCl_4 . Its analysis is performed by breaking in a stoppered flask, and containing dilute ammonia, a glass bubble filled with the substance. When decomposition ceases, the liquid is evaporated in the same flask over a water-bath, a current of air being passed into it by means of an aspirator, and the liquid produced by evaporation condensed in a cool receiver. Without the latter precaution part of the iodine would be lost. After evaporation to dryness, the residue is taken up by the condensed water, filtered, and washed; and in order to obtain the weight of the silica, it is merely necessary to deduct from the weight found, that of the bubble. The iodine is precipitated in the filtering liquid. Thus figures are found agreeing with the formula SiI_4 . Following the excellent process of MM. Sainte-Claire Deville and Troost, the density of its vapour was taken in mercurial vapour. It was found indispensable to fill the globe with carbonic acid, and sundry precautions were used to prevent the re-entrance of air. At the close of the experiment, the globe proved to contain no free iodine. The number obtained for the density was 19.12. The theoretical value corresponding with the formula SiI_4 , and with two volumes of vapour is 18.56. These results complete the analogy of iodide of silicium with the chloride.

Not so in all its reactions. If absolute alcohol be allowed to fall upon iodide of silicium drop by drop, a quick liberation of iodhydric acid ensues, but there is no formation of silicic ether. Iodide of ethyl mixed with alcohol is produced on distillation if four molecules of alcohol be employed to one of iodide, and a spongy mass of silica remains in the receiver.

The reaction is explained by the equation—



Silici-iodoform.—Iodide of silicium being thus obtained pure, the hydrogenised body now remained to be isolated. I believed it might be possible, by causing iodhydric acid to act upon silicium in the presence of hydrogen, to augment the quantity produced from the reaction of MM. Wöhler and Buff. This belief has in fact been realised, and although the proportion obtained is still small, a sufficient quantity of the new compound may be procured to enable us to determine its principal properties. Little drops of it are condensed in the cool end of the tube at the same time

* *Annalen der Chemie und Pharmacie*, clv. 99.

as the iodide of silicium; these may be partially isolated by decantation. A small quantity of the liquid product was also obtained by distilling the crystallised mass imbued with the liquid, and after tedious operations twenty grammes were collected of a colourless liquid highly refractive, and very dense, boiling at about 220° , and shown by analysis to possess the composition SiH_2 .

This body may therefore be called *silici-iodoform* from its analogy with *silicichloroform*. When decomposed by water it yields, like the chlorine compound, a white substance which liberates hydrogen. This is doubtless no other than the siliciformic anhydride, whose composition was made known by M. Ladenburg and myself.

The density of *silici-iodoform* is 3.362 at 0 , and 3.314 at 20° , without correction for the dilatation of glass. Its density is almost as great as that of thallic alcohol. It may perhaps be slightly diminished, as the product upon which I experimented still contains traces of iodide of silicium. As the extreme stability of the chloride of silicium and *silicichloroform* is not shared by the iodide of silicium and *silici-iodoform*, it is to be hoped that, by means of these latter, new compounds may be formed which were unobtainable by employment of the chloride.—(*Comptes Rendus*, lxxvii., 98.)

ON THE

PRODUCTION OF CHLORINE AND OXYGEN.

BY M. A. MALLET.

I HAD occasion last year to call the attention of the Academy to my process of preparing oxygen. I then pointed out, amongst its other advantages, the possibility of also obtaining chlorine by the simple addition of chlorhydric acid. As certain novel, or but slightly known, reactions have brought this process into some note, a few explanations are necessary. The fixation of atmospheric oxygen upon protochloride of copper allows two results to ensue; either the disengagement of oxygen, supposing the desired end be to collect that gas, or the decomposition of chlorhydric acid and liberation of chlorine, should the production of that body be desired.

The absorption of oxygen by protochloride of copper is spontaneous, and takes place at the ordinary temperature in a few hours, provided the air be sufficiently moist, and especially if the surfaces be renewed. If the temperature be raised the absorption is more rapid, and this is the most important part of the question, for by raising the temperature to between 100° and 200° or even higher, in the presence of steam, absorption may be considered as almost instantaneous.

A demonstration of this may be made by means of a balloon containing some grammes of protochloride of copper, and communicating with a graduated receiver. The balloon is then heated, and by means of a suitable arrangement several drops of water are injected upon the substance without allowing any communication with the exterior air; absorption takes place immediately, and the water rises in the receiver. By restoring the apparatus to its original temperature and pressure, the oxygen will prove to be completely absorbed provided the substance should have been suitably proportioned. Thus the protochloride of copper may be reoxidised in a few minutes at a temperature differing but slightly from that required for deoxidation, a fact which is of great industrial importance with regard to continuity of operation.

If upon protochloride of copper, heated to 100° or 200° ,

commercial chlorhydric acid be slowly dropped, steam alone will be disengaged, and supposing the addition of acid to be slow enough, and the access of air and renewal of surface sufficient, the odour of chlorhydric acid will be scarcely perceptible, and the whole protochloride will transform into anhydrous bichloride, CuCl_2 , which, when heated in a close vessel, instantly disengages chlorine. The simultaneous absorption of oxygen and chlorhydric acid is an important fact and interesting to know, because the extraction of the chlorine from the acid takes place in this case by means of the atmospheric air, and in an absolutely direct manner. With gaseous chlorhydric acid the action is the same, in fact better, provided the acid gas contain, as is always the case, a certain quantity of steam, and that the accession of air be sufficient.

The presence of water is necessary to the absorption of oxygen by protochloride of copper.

Oxidation and chlorination take place very quickly at high temperatures, but the great advantage is that they yield dry products, which is very convenient, inasmuch as steam is frequently a source of inconvenience and alteration of apparatus.

The retorts which I employ are rotatory, and serve either for decomposition or vivification; they are made of cast iron, and a simple refractory coating in the interior effectually preserves the metal from destruction. The reactions described have been demonstrated upon quantities of matter large enough to produce, after each operation, several cubic metres of oxygen or chlorine. From a manufacturing point of view, it may be considered that 100 kilogrammes of protochloride of copper, mingled with sufficient inert matter to facilitate manipulation, will produce practically from three to three and a half cubic metres of oxygen, or from six to seven cubic metres of chlorine. As four or five operations at least may be performed in twenty-four hours; it is plain that 100 kilogrammes of substance will produce from fifteen to eighteen cubic metres of oxygen, or from 200 to 300 kilogrammes of chloride of lime, in twenty-four hours.

The price of the raw material does not exceed one franc the kilogramme, and the loss is ascertained by experience to be always very small; this is easily understood as the substance does not leave the retort, but undergoes all the processes within it.—(*Comptes Rendus*, lxxvi., 349.)

ON THE BLEACHING OF PALM OIL.

BY M. ENGELHARDT.

M. ENGELHARDT, of Leipsic, effects in the following manner the blanching of palm oil by means of bichromate of potash and chlorhydric acid:—

A given quantity of palm oil is placed in an iron pot, heated to about 62° C., and allowed to stand all night. The next day it is poured into a clean vessel and cooled to 40° or 37° C. Meanwhile a certain quantity of water, say for instance 45 kilogrammes of water to 1,000 of palm oil, is set to boil; in it are dissolved 15 kilogrammes of bichromate of potash, and when the solution has cooled a little, 60 kilogrammes of chlorhydric acid are added. This mixture is then poured into the palm oil, which must be quickly stirred, and in about five minutes it will assume a sombre green colour from the reducing action of the combination of the chromate with the chlorhydric acid. By continuing to stir, the separation of the oxide of chromium is completed, and the oil gradually clarifies and becomes at last quite limpid. In order to render it quite white it is now only

necessary to wash it in warm water; if, however, it should not appear quite colourless, the operation must be repeated with 0.25 kilogrammes of red chromate and 1 kilogramme of chlorhydric acid. This method is quick, free from danger, and produces very good results. The author declares that the new methods in which either gaseous chlorine, chloride of lime, or a mixture of chlorhydric acid with peroxide of manganese are proposed, are much inferior to the above process.—(*Dingler's Polytechnisches Journal*.)

TRANSFORMATION OF THE AROMATIC MONAMINES INTO ACIDS RICHER IN CARBON.*

III. MENAPHTHYLAMINE.

BY A. W. HOFMANN, LL.D., F.R.S.

THE transformation of naphthaline into its carboxylic acid suggests the existence of a large number of compounds which the progress of science cannot fail to realise. It is not my intention to examine in detail this group of substances, the composition and even the properties of which are sufficiently indicated by theory. There are, nevertheless, several terms of this series which I must not leave unprepared whilst engaged with this question. These are the aldehyde, the alcohol, and the monamine of the series.

My first attempts to produce the aromatic monamine were anything but successful. Cyanide of naphthyl, when left in contact with zinc and sulphuric acid, even for weeks, was found to yield but trifling quantities of menaphtylamine. The greater portion of the nitrile was left unchanged, while more or less, by the absorption of the elements of water, was converted into menaphtoxyamide, and even into menaphtoxylic acid. A slight modification, however, of the process usually adopted has removed these difficulties.

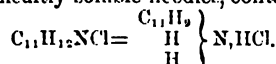
It is well known that M. Mendius, after he had discovered the remarkable property possessed by nitriles of fixing two molecules of hydrogen, has submitted also the amides to the action of hydrogen *in conditione nascendi*, in the hopes of replacing their oxygen by hydrogen, and of producing also in this manner the primary monamines. These experiments have not been successful. In the presence of the difficulties attending the preparation of menaphtylamine, the idea suggested itself of trying whether the sulphuretted amide of the series into which the nitrile is so easily transformed would not be more readily attacked by nascent hydrogen than the nitrile itself. The result of this experiment was highly satisfactory. On submitting an alcoholic solution of menaphtothiamide to the action of zinc and hydrochloric acid, torrents of sulphuretted hydrogen are at once evolved. The addition of zinc and hydrochloric acid, and sometimes also of a little alcohol, is continued, until, after a day or two, the disengagement of sulphuretted hydrogen almost ceases. The liquid is now mixed with concentrated soda until the precipitate of hydrate of zinc, which is formed in the commencement, is redissolved. An oily layer, containing much soda and alcohol, is seen to separate and to collect on the surface of the aqueous solution. This layer is removed and heated in the water-bath until the alcohol is volatilised. An aqueous liquid is thus produced, on which a yellow oil is floating. The latter is principally menaphtylamine, which is still mixed with a small quantity of cyanide of naphthyl regenerated from the thio-compound. The oil is treated with dilute hydrochloric acid, the hydrochloric liquid separated by

filtration from the cyanide, and decomposed by hydrate of sodium, when the base separates in a state of purity.

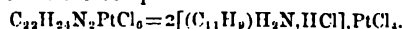
Menaphtylamine is a very caustic liquid, boiling between 290° and 293°. Freshly distilled it is colourless, but soon acquires a yellow tint. It attracts carbonic acid with such avidity that it is impossible to pour it from one vessel into another without a pellicle of the difficultly soluble carbonate being formed on its surface.

The composition of the base was sufficiently indicated by theory; it appeared, nevertheless, desirable to establish it experimentally by the analyses of the hydrochlorate and the platinum salt.

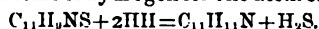
The hydrochlorate crystallises with the greatest facility in difficultly soluble needles, containing—



The yellow crystalline precipitate which is formed by the addition of perchloride of platinum to the hydrochlorate has the composition



The transformation of the thio-compound into menaphtylamine is thus seen simply to consist in the substitution of two atoms of hydrogen for one atom of sulphur:—



I have but little to say about the properties of menaphtylamine; nevertheless, the extraordinary crystalline tendencies of its salts deserve to be mentioned. The sulphate and nitrate are likewise difficultly soluble; the latter crystallises in splendid nitre-like prisms. In contact with bisulphide of carbon, menaphtylamine solidifies at once to a crystalline mass. When treated with alcoholic soda and chloroform, it is converted into the terribly-smelling formo-menaphtylnitrile, which I propose to examine somewhat more in detail.

I have also prepared benzylamine, starting from thio-benzamide instead of benzonitrile. The experiment is, of course, likewise successful—the advantage, however, less conspicuous—since benzonitrile fixes hydrogen with far greater facility than the cyanide of naphthyl.

Be this, however, as it may, the facility with which hydrogen *in conditione nascendi* acts upon sulphur-compounds deserves to be noticed. I propose to examine, in the direction indicated by the above experiments, some of the more important sulphur-compounds, more especially the thio-acids of the fatty and aromatic series, and the two groups of sulpho-cyanic ethers. The investigation of the latter, indeed, has already furnished me results of great neatness and precision.

In conclusion, I must not leave unmentioned that, since my first communication on the menaphtan series, I have had an opportunity of removing the slight doubts, respecting the identity of the acid obtained by the action of oxalic acid upon naphthylamine, with that procured by treating a naphthalin-sulphate with cyanide of potassium. M. V. Merz had found the fusing-point of the latter acid to be 140°, whilst for the former I had observed the fusing-point 160°. M. O. O'Shaughnessy has since prepared, in my laboratory, a quantity of cyanide of naphthyl, according to Merz's process. The acid obtained from this cyanide, by treatment with an alkali thrice recrystallised and finally purified by distillation, was likewise found to fuse exactly at 160°. Menaphtoxyamide, procured from the same source, exhibited the fusing-point 203°, while the compound I had formerly examined fused at 204°. The identity of the acids obtained by the two processes is thus satisfactorily established.

* The fusing-point of this substance is, by misprint (*Proc. Roy. Soc.*, vol. xvi., p. 302), stated to be 244°, instead of 204°.—A. W. H.

* Read before the Royal Society, June 13th, 1868.

ON THE PREPARATION OF URIC ACID FROM PERUVIAN GUANO.

BY DR. JULIUS LÖWE.

To prepare uric acid from Peruvian guano in large quantities the following method is preferable:—Take equal weights of common sulphuric acid and Peruvian guano; heat the sulphuric acid in a porcelain capsule by means of a water-bath, and add to it little by little the guano, previously pounded and dried at 100° C., stirring well with a glass rod. When large quantities are used, the necessity of introducing the guano very gradually is all the greater, as the surface of the mixture is covered with froth, and a liberation of much carbonic and chlorhydric gas occurs, which will cause the mixture to run over unless the top of the capsule present a wide empty space. The strong exhalations of chlorhydric gas consequent upon this process are so unpleasant that, where operations are on a large scale, it is advisable to arrange the laboratory so as to facilitate their escape to the exterior. As long as these exhalations continue, the pasty compound thus obtained should remain in the water-bath; but when the odour has become faint and the mass appears thoroughly homogeneous, it must be diluted with ten or twelve times its quantity of distilled water. The yellow precipitate which then falls is allowed to settle in a large vessel, the supernatant liquid is decanted, and the precipitate well washed by agitation with plenty of pure water. It is then placed upon a good and easily permeable filtering paper, upon which it is again washed with cold water until the greater part of the sulphuric acid has been removed. This precipitate is now boiled in a weak alkaline solution in small portions at a time, producing a liquid which is filtered, and receives an addition of dilute chlorhydric acid which precipitates the uric acid in the form of a yellow cloud, which quickly thickens and falls in a crystalline powder. When this point has been reached, and the liquid has cooled, the acid is collected on a filter, washed, and dried. If it be desirable to remove the yellow colour which remains it will only be necessary to heat it again in a water-bath with its own weight of common sulphuric acid, and repeat the process above described. Frequently after the second solution of the uric acid, the warm mixture will take the form of a crystalline mass composed of sulphuric and uric acids. When examined with the microscope the crude acid appears to be an homogeneous mass, burns without residuum and contains only traces of guanine, which may be perceived by boiling the mass in chlorhydric acid. In thus purifying the crude uric acid by a second solution in sulphuric acid, care must be taken to add only the quantity of water necessary to deposit the uric acid, and that very gradually, as an excess of water always communicated a yellow colour to this acid, and the matter which causes it appears to be more soluble in concentrated than in dilute sulphuric acid.

The modes of purification proposed by MM. Wöhler and Heintz have had equal success with the crude acid obtained by the process above described; M. Heintz's especially was successful in the first operation.—(*Journ. für Praktische Chemie.*)

ON FOOD.*

BY DR. LETHBY, M.A., M.B., ETC.

Varieties of Food—their Chemical and Composition Nutritive Value.

THE economy of food, in its fullest signification, is a

* The Cantor Lectures, delivered before the Society of Arts.

matter of national importance; for the political influence of a nation is as much dependent upon the muscular strength of the people as upon their intelligence and commercial industry; and this strength is wholly referable to a right use and proper distribution of food.

We perceive this not merely in the calamities of actual want, as in the fevers of famine, but also in the less prominent, but equally significant, decline of health in times of partial distress, when the vigour and energy of the poorer part of the population are so reduced as to lay them open to disease. In fact, the experience of our public hospitals too often elicits the fact that the wasted power of the patient has been the advent of incurable disease. Nor is this all; for as Mr. Simon observes—"Long before insufficiency of diet is a matter of hygienic concern; long before the physiologist would think of counting the grains of nitrogen and carbon which intervene between life and starvation, the household will have been utterly destitute of material comfort; clothing and fuel will have been scantier than food; against inclemencies of weather there will have been no adequate protection; dwelling-space will have been stinted to the degree in which overcrowding produces or increases disease; the home will be where shelter can be cheapest bought, where sanitary appliances are least considered, and where cleanliness is almost impossible." And all this distress falls heaviest upon those who are least able to bear it—the mother and her children; for the father, to be able to work, even lightly, must eat, and thus the others are the largest sufferers. Bad, however, as the immediate consequences are, they are nothing in comparison to the remote—the sickly race that comes of want.

In examining, therefore, this question of the economy of food, we must not only look at the nutritive value of different articles of diet, but we must also consider how food can be best distributed and utilised.

To-day we will investigate the principal varieties of food, and ascertain their peculiar qualities and dietetical values. For this purpose it will be necessary to have some standard for comparison, but this is avowedly a difficult matter; for if we compare foods according to the proportions of their principal constituents—viz., albuminous matters, starchy, saccharine, and saline—we shall find that the relative quantities vary to such a degree as to make the comparison almost useless; and if we fix our attention on one of these constituents—the nitrogenous, for example—and make it the exponent of nutritive value, we get into the difficulty of either overloading the equivalent with a large amount of carbonaceous material, or of having it deficient therein. If, for instance, we desire to know the quantities of different foods which would furnish the 1,200 grains of nitrogenous matter required by a man in his daily diet, we should find that the following are the proportions:—

TABLE I.

Proportions of Different Foods Required to Yield 1,200 Grains of Nitrogenous Matter.

	Grains.	Pounds.
Skim cheese.....	2,681	— 0.4
Lean meat.....	6,217	— 0.9
White fish.....	6,630	— 1.0
Fat meat.....	9,231	— 1.3
Fat bacon.....	13,636	— 2.0
Bread.....	14,815	— 2.1
Rice.....	19,048	— 2.7
New milk.....	29,268	— 4.2

	Grains.	Pounds.
Potatoes.....	57,143	— 8'2
Parauips or turnips....	100,000	— 14'3
Beer or porter.....	1,200,000	— 171'4

In this manner tables have been constructed of the nutritive values of food, and I show you one of them.

TABLE II.

Nutritive equivalents—calculated according to the amounts of Nitrogen in the Dry Substances; Human Milk being 100:—

VEGETABLE.	
Rice.....	81
Potatoes...	84
Maize.....	100
Rye.....	106
Radish.....	106
Wheat.....	119
Barley.....	125
Oats.....	138
White bread	142
Black bread.	166
Peas.....	239
Lentils.....	276
Haricots...	283
Beans.....	320
ANIMAL.	
Human milk	100
Cow's milk.	237
Yolk of egg.	305
Oysters....	305
Cheese.....	331
Eel.....	434
Mussel....	528
Ox-liver....	570
Pigeon.....	756
Mutton...	773

Salmon.....	776
Lamb.....	883
White of egg.	845
Lobster...	859
Skate.....	859
Veal.....	873
Beef.....	880
Pork.....	893
Turbot.....	898
Ham.....	910
Herring....	914

I hardly need say that comparisons of this description are of little practical value, for they furnish no indication of the digestive labour required to utilise the products; besides which we are far from being assured, at the present time, that the nitrogenous elements of our foods are the most important.

In framing, therefore, a table of alimentary equivalents, regard must be paid to all the constituents. This I have endeavoured to express in Table No. 3, wherein I have shown the per cent of nitrogenous and carbonaceous matter, and the proportions of the latter to one of the former; but here again the actual value of the several carbonaceous compounds is very different; for, although the fattening and respiratory powers of starch, gum, sugar, and pectin, may be nearly the same, yet the power of fat is about 2'5 times as great as that of sugar; and this must be considered, irrespective of other functions of fat, in estimating the value of carbonaceous food.

TABLE III.—NUTRITIVE VALUES OF FOOD.

	WATER.	ALBUMEN, &c.	STARCH, &c.	SUGAR.	FAT.	SALTS.	TOTAL PER CENT.	Carbonaceous to one Nitrogenous.
							Nitroge- nous.	Carbona- ceous.
Bread.....	37	8'1	47'4	3'6	1'6	2'3	8'1	52'6
Wheat flour.....	15	10'8	66'3	4'2	2'0	1'7	10'8	72'5
Barley meal.....	15	6'3	69'4	4'9	2'4	2'0	6'3	76'7
Oatmeal.....	15	12'6	58'4	5'4	5'6	3'0	12'6	69'4
Rye meal.....	15	8'0	69'5	3'7	2'0	1'8	8'0	75'2
Indian meal.....	14	11'1	64'7	0'4	8'1	1'7	11'1	73'2
Rice.....	13	6'3	79'1	0'4	0'7	0'5	6'3	80'2
Peas.....	15	23'0	55'4	2'0	2'1	2'5	23'0	59'0
Arrowroot.....	18	—	82'0	—	—	—	—	82'0
Potatoes.....	75	2'1	18'8	3'2	0'2	0'7	2'1	22'2
Carrots.....	83	1'3	8'4	6'1	0'2	1'0	1'3	14'7
Parauips.....	82	1'1	9'6	5'8	0'5	1'0	1'1	15'9
Turnips.....	91	1'2	5'1	2'1	—	0'6	1'2	7'2
Sugar.....	5	—	—	95'0	—	—	—	95'0
Treacle.....	23	—	—	77'0	—	—	—	77'0
New milk.....	86	4'1	—	5'2	3'9	0'8	4'1	9'1
Cream.....	66	2'7	—	2'8	26'7	1'8	2'7	29'5
Skim milk.....	88	4'0	—	5'4	1'8	0'8	4'0	7'2
Buttermilk.....	88	4'1	—	6'4	0'7	0'8	4'1	7'1
Cheddar cheese.....	36	28'4	—	—	31'1	4'5	28'4	31'1
Skim do.....	44	44'8	—	—	6'3	4'9	44'8	6'3
Lean beef.....	72	19'3	—	—	3'6	5'1	19'3	3'6
Fat do.....	51	14'8	—	—	29'8	4'4	14'8	29'8
Lean mutton.....	72	18'3	—	—	4'9	4'8	18'3	4'9
Fat do.....	53	12'4	—	—	31'1	3'5	12'4	31'1
Veal.....	63	16'5	—	—	15'8	4'7	16'5	15'8
Fat pork.....	39	9'8	—	—	48'9	2'3	9'8	48'9
Green bacon.....	24	7'1	—	—	66'8	2'2	7'1	66'8
Dried do.....	15	8'8	—	—	73'3	2'9	8'8	73'3
Ox liver.....	74	18'9	—	—	4'1	3'0	18'9	4'1
Tripe.....	68	13'2	—	—	16'4	2'4	13'2	16'4
Poultry.....	74	21'0	—	—	3'8	1'2	21'0	3'8
White fish.....	78	18'1	—	—	2'9	1'0	18'1	2'9
Eels.....	75	9'9	—	—	13'8	1'3	9'9	13'8
Salmon.....	77	16'1	—	—	5'5	1'4	16'1	5'5
Entire egg.....	74	14'0	—	—	10'5	1'5	14'0	10'5
White of do.....	78	20'4	—	—	—	1'6	20'4	—
Yolk of do.....	52	16'0	—	—	30'7	1'3	16'0	30'7
Butter and fats.....	15	—	—	—	83'0	2'0	—	83'0
Beer and porter.....	91	0'1	—	8'7	—	0'2	0'1	8'7

Another method of determining the values of food is by estimating the proportions of nitrogen and carbon in them, and comparing them with the proportions required in a standard diet.

Judging from the minimum quantities of food which an ordinary individual is capable of existing on without suffering in health, it would seem that about 4,100 grains of carbon, and 190 grains of nitrogen, are required in his daily diet. These proportions have been determined from a large number of observations, as by those of Dr. Lyon Playfair, in his inquiries into the dietaries of hospitals, prisons, and workhouses, and by those of Dr. Edward Smith, in his examination of the amounts of food which the Lancashire operatives were capable of living on during the cotton famine, and also by his inquiries into the dietaries of in-door labourers.

The proportions which Dr. Smith gives as a famine or barely sustaining diet, are the following:—

	Carbon (grains).	Nitrogen (grains).
Adult woman	3,900	180
Adult man	4,300	200
Average adult	4,100	190

These proportions are contained in 2 lbs., and in 2 lbs. 3 oz. of bread; and they closely accord with another set of facts derived from an examination of the amounts of carbon and nitrogen exhaled and secreted from the body during health and idleness.

Taking these numbers, therefore, as the exponents of the nutritive values of food, we are able to construct the following table:—

TABLE IV.—NUTRITIVE VALUES OF FOOD.

	GRAINS PER POUND.		VALUE PER POUND.	GRAINS FOR ONE PENNY.		WEEKLY COST OF FAMINE DIET FOR	
	Carbon.	Nitrogen.	d.	Carbon.	Nitrogen.	d.	Nitrogen.
Split peas.....	2730	255	1	2730	255	10.5	5.2
Indian meal.....	2800	123	1	2800	123	10.2	10.8
Barley meal.....	2730	70	1	2730	70	10.5	19.0
Rye meal.....	2660	88	1½	2128	70	13.5	19.0
Seconds flour.....	2660	120	1½	1773	80	16.2	16.6
Oatmeal.....	2800	140	2	1400	70	20.4	19.0
Bakers' bread.....	1995	90	1½	1330	60	21.6	22.1
Pearl barley.....	2660	91	2	1330	45	21.6	29.5
Rice.....	2730	70	2	1365	35	20.5	38.0
Potatoes.....	770	24	0½	1540	48	18.6	27.7
Turnips.....	238	13	0½	476	26	60.3	51.1
Green vegetables.....	420	14	0½	840	24	34.1	55.4
Carrots.....	385	14	1	385	14	74.8	95.0
Parsnips.....	421	12	1	421	12	66.4	110.8
Sugar.....	2800	—	5	560	—	51.2	—
Treacle.....	2200	—	1	2200	—	13.0	—
Buttermilk.....	335	35	0½	670	70	42.8	19.0
Whey.....	154	13	0½	626	52	45.8	25.6
Skimmed milk.....	350	34	1	350	34	82.2	39.1
New milk.....	378	35	2	189	18	154.0	73.9
Skim cheese.....	2348	304	3	783	121	36.6	11.0
Cheddar do.....	2520	315	8	315	39	91.1	34.1
Bullocks' liver.....	1226	210	3	408	70	70.3	19.0
Mutton.....	2902	140	5	580	28	49.5	47.5
Beef.....	2301	175	8	288	22	99.6	60.5
Fresh pork.....	2950	108	7	421	15	68.1	88.7
Dry bacon.....	4270	98	9	474	11	60.5	120.9
Green do.....	3990	79	8	492	10	58.3	133.0
White fish.....	900	130	2	450	65	63.8	20.4
Red herrings.....	1435	217	4	359	54	80.0	24.6
Dripping.....	5320	—	6	887	—	32.3	—
Suet.....	4710	—	7	673	—	42.6	—
Lard.....	4819	—	9	535	—	53.6	—
Salt butter.....	4585	—	12	382	—	75.1	—
Fresh do.....	4712	—	16	294	—	97.6	—
Cocoa.....	3934	140	4	983	35	29.2	38.0
Beer and porter.....	315	1	1	315	1	91.1	1330.0

And now we may proceed to examine in detail the general properties and the nutritive qualities of different foods.

Primarily, all our foods are derived from the vegetable kingdom, for no animal has the physiological power of associating mineral elements and forming them into food. What we may yet do by means of chemical agencies in the laboratory is another question; but within our own bodies there is no faculty for such conversion. As I shall hereafter explain to you, our functions are of an opposite kind. We are destructive creatures, not constructive. It is our province to pull down what the vegetable has built up; to let loose the

affinities which the plant has brought into bondage, and to restore to inanimate nature the matter and chemical force which the growing plant had taken from her.

Foremost, therefore, of our foods are those which come at once from the vegetable kingdom; and of these the cereals are the most important, as wheat, barley, oats, rye, maize, or Indian corn, rice, millet or dura, and Guinea corn.

Wheat.—Different species of this grain are cultivated, but the most common in this country is *Triticum vulgare*, of which there is a summer and winter variety.

The grain varies a good deal in composition accord-

ing to season, climate, and soil; but, as a rule, the wheat of southern climates and warm seasons is richer in gluten, and of harder texture than that of colder climates. They are then called stronger grains, although the latter, from their being softer and kinder, give a larger proportion of flour. Some of the hardest varieties of wheat, as rivets, are used to strengthen the flour of new grain, which is always unmanageable, and to improve that of bad seasons and of damaged quality.

The structure of the grain is like that of all the cereals; there is an outer siliceous and woody covering, which is altogether valueless as food; then there is a layer of rich nitrogenous matter, containing a digestive body called cerealine, and within that is the flour, which forms the great bulk of the seed.

When ground whole, it forms brown meal, which is rarely used in England at the present time, although it was the common food of our forefathers, and even now is much employed in Westphalia to make the dark-coloured bread called pumper-nickel. It contains from 5 to 12 per cent of indigestible matter, in the form of bran, the removal of which, according to Liebig, is only a refinement of luxury.

The practice at the present time is to bolt or sift the ground meal through sieves, or silks, of different degrees of fineness, and thus to remove the coarser bran. The products have different names in different places, and have also different values; but generally 100 lbs. of wheat will yield from 78 to 80 parts of good serviceable flour. The other products are about 2 parts of specks, or tails, or tippings; from 2 to 3 parts of sharps; about 3 of fine pollard; from 3½ to 6 of coarse pollard; and from 4 to 10 of bran. The relative wholesale values of these are about as follows:—

Vegetable Foods.	lbs. per bushel.	Price per bushel. s. d.	Price per 20 lbs. s. d.
Fine flour.....	56	10 0	3 7
Seconds ditto....	56	7 9	2 9
Sharps.....	26	2 0	1 6
Fine pollards.....	18	1 0	1 1
Coarse ditto.....	14	0 10	1 2
Bran.....	12	0 9	1 3

Seconds flour is practically the best for domestic use; and of this there should be at least 80 per cent obtained from the grain. Attempts have often been made to increase the produce; for as the bran contains a good deal of nitrogenous matter, and is, moreover, rich in fat and saline substances, it has been thought wasteful to remove it; but the experimental researches of Poggiale, the learned professor at Val-de-Grace, have shown that at least 50 per cent of the bran is perfectly indigestible, and may be passed successively through the bodies of four or five animals without undergoing change. It, moreover, acts as an irritant; and, by hurrying the food through the alimentary canal, is very likely to cause waste. Those who labour hard, as railway navigators, invariably choose the whitest bread for food, believing that it is not only more digestible, but it is stronger, and will enable them to do more work. Without doubt, however, there is room for improvement in the treatment of flour, and in the complete utilisation of its several constituents. M. Mège Mouries has invented a process whereby the outer skin only of the wheat may be removed, and from 86 to 88 per cent of flour realised. The process was examined in 1857, and reported very favourably of by Dumas, Peouze, Payen, Peligot, and Chevreul, but I am not aware that it has come into use.

M. Mège Mouries also directed attention to the fact that the bran contains a portion of very soluble nitrogenous matter, cerealine, which is of the nature of diastase, and has the property of dissolving starch. This, no doubt, might be utilised by treating bran with warm water, and then using the water in the manufacture of bread.

The nutritive value of wheat is shown in Tables No. 3 and No. 4; and although the average amount of gluten is there set down at about 11 per cent, it ranges from 8 to 15 per cent—the largest quantity being found in the wheaten flour of India, Egypt, South America, and the South of Europe.

It appears, too, that the quantity of gluten, as represented by nitrogen, increases with the coarseness of the flour, and so, also, does the amount of mineral matter.

TABLE V.

Percentage amounts of Nitrogen and Mineral Matter in the different Products of the Mill:—

	Nitrogen.	Mineral matter.
Fine flour.....	1.70	0.71
Tails.....	1.86	0.99
Fine sharps.....	2.21	1.80
Coarse do.....	2.58	3.80
Fine pollard.....	2.44	5.50
Coarse do.....	2.42	6.50
Bran.....	2.39	7.00
Average in whole grain	1.82	1.62

The starch and sugar amount to about 70.5 per cent, and the fat to 1.7; so that the carbonaceous is to the nitrogenous as 6.7 to 1, which is a good proportion. Other facts relating to its nutritive value are shown in Table No. 4.

The tests for a good flour are its sweetness and freedom from acidity or musty flavour; and its nutritive value, as far as gluten is concerned, is estimated by the process of Beccaria, who discovered gluten in wheat more than a century ago. A given weight of flour (say 500 grains) is made into a stiff dough, and is carefully washed by tender manipulation under a small stream of water. The gluten remains, and when baked it expands into a clean-looking ball, which should weigh, when thoroughly dried, about 54 grains.

Of all the preparations of flour, bread is the most important. I shall hereafter describe the process of making it, but I may here remark that it should not contain more than from 36 to 38 per cent of water, and the other constituents, excepting salt, should be the same as of good flour.

In practice, 100 lbs. of flour will make from 133 to 137 lbs. of bread, a good average being 134; so that a sack of flour of 286 lbs. should yield 95 four-pound loaves. The art of the baker, however, is to increase this quantity, and he does it by hardening the gluten through the agency of a little alum, or by means of a gummy mess of boiled rice, 3 or 4 lbs. of which will, when boiled for two or three hours in as many gallons of water, make a sack of flour yield 100 four-pound loaves. But the bread is dropsical, and gets soft and sodden at the base where it stands. A good loaf should have the following characters:—

Kindness of structure—that is, not chaffy, or flaky, or crummy, or sodden; and
Sweetness to the palate and to the smell.

Wheaten bread is best eaten on the day after it is

baked, for new bread is difficult of mastication, and still more difficult of digestion, because of its gummy nature. When it becomes stale it does not really get much dryer, but it undergoes a molecular change, which may be restored by heating the bread in a closed vessel to a temperature of 212° .

Wheaten bread is preferred to all other varieties of bread, because of its sweetness, and because it may be eaten alone. The nutritive constituents of it are in the same proportion as in wheat—namely, as 1 to 6.5, and a little more than 2 lbs. of bread will supply the requirements of the system; although, as I shall hereafter explain, it cannot be used alone without loss of health and strength.

Barley-meal is the chief food of a large number of people in the North of Europe and in the South of England, where the labourer is partly paid his wages in meal or grain. It is also used in Wales and Scotland, especially in winter time, when wheaten bread is dear; and to some extent in Ireland. It is employed by about 90 per cent of the outdoor labouring population of England. At the time of Charles I. (in 1626), according to McCulloch, it was the usual food of the ordinary sort of people; and as late as the middle of the last century hardly any wheat was used in the northern counties of England. In Cumberland the principal families used only a small quantity about Christmas-time; and the crust of the everlasting goose pie, which adorned the table of every country family, was invariably made of barley-meal.

The grain is almost always ground whole, and the farina has much resemblance to wheaten flour; but the amount of gluten is very different—in fact, the nitrogenous matter, which amounts to about 6 per cent, is chiefly in the form of albumen—hence, the bread is heavy and compact, for albumen will not vesiculate or sponge like gluten. The common way of making it into bread is by mixing it with an equal proportion of wheaten flour; and sometimes it is mixed with oatmeal and rye-meal, and baked into cakes. But the best way of using it is in the form of thick gruel or stirabout, which is made by stirring the meal into boiling water.

Pearl Barley and *Scotch Barley* are the grain deprived of its husk, and rounded by attrition. The former is more carefully prepared than the latter, but both are used to give consistence to broth.

The nutritive value of barley-meal is somewhat inferior to that of wheaten flour, but as the meal is cheaper than flour, it is more economical to use it; in fact, it is almost the cheapest article of diet, as may be seen by reference to Table No. 4.

Oatmeal and rye bread were once the chief diet of the servants of the wealthy, and even now the former is used by 90 per cent of the agricultural labourers of England, and by a still larger proportion of the Scotch. The grain is very rich in gluten and fat, and it contains a good quantity of sugar and starch, the microscopic form of which is remarkable. The Scotch meal is always preferable to the English, on account of its higher nutritive power. It is prepared by grinding the kiln-dried grains, previously deprived of their skins. The Scotch grind it rather coarsely as compared with the practice in England.

Oatmeal is not nearly so white as wheaten flour, and its taste is peculiar, being at first sweet, then rough and bitter. Like barley-meal, it cannot be vesiculated into bread, but it makes good cakes, and these may be highly leavened, as is the custom in Yorkshire, or unleavened, as in Scotland.

The common method of cooking it, however, is by stirring it into boiling water until it has the consistence of hasty pudding, and in this manner porridge is made; but if it be afterwards boiled for a short time it makes Scotch brose. In Ireland it is mixed with Indian-meal, and then stirred into boiling water, thus making the mixture called stirabout.

The decorticated grain constitutes grits or groats, and when these are crushed or bruised they go by the name of Emden groats. The sole use of them is for making gruel, a drink that seems to have been a favourite with our forefathers; for in the *London Gazette*, for Friday, August 13, 1695, there is an advertisement to the effect that water-gruel was always ready at the Marine Coffee-house, in Birchin lane, Cornhill, every morning from six to eleven o'clock; and, it added, that as much as from four to five gallons of it were consumed there daily.

The husks of the grains are sold in Scotland under the name of seeds, and these, when steeped in water for a few days, until they become a little sour, like stale brewers' grains, and then squeezed out, produce a liquid which, when boiled down to the consistence of gruel, makes the food called flummery or sowans in Scotland, and sucan in South Wales. If it be boiled still more, until it becomes as thick as jelly, it forms budrum, or brwehan as it is named in Wales. Oatmeal is, no doubt, rather hard of digestion, and causes irritation of the bowels. There is a notion also that it produces heat and irritation of the skin; and formerly, when sufficient care was not taken to remove the husk from the grain before it was ground, it was not an uncommon occurrence to find calculi or concretions of phosphate of lime, mixed with the silky bristles of the grain, in the alimentary canal. Somewhat similar concretions are found at the present time in the bowels of horses that feed too freely on bran or grains. The nutritive value of oatmeal is shown in Tables No. 3 and No. 4, and it will be noticed, that although it is, weight for weight, more nutritive than wheaten flour, yet, considering its price, it is not so economical.

Rye meal is the chief food of northern nations, and was once a common article of diet with ourselves. It forms the dark-coloured and sour-tasting bread of the North of Europe. In this country it is rarely eaten alone, but it is mixed with about twice its bulk of wheaten flour, forming what in many places is called maslin, and is then made into bread. The nutritive power of rye-meal is a little less than that of flour, and the proportion of the nitrogenous to the carbonaceous constituents is as 1 to 9.4.

(To be continued.)

ON THE EXTRACTION OF OIL BY MEANS OF SULPHIDE OF CARBON.

BY M. HEYL.

A NEW and interesting process for the extraction of oil by means of sulphide of carbon is carried out on a large scale at the manufactory of M. E. O. Heyl, at Moabit, near Berlin.

With respect to this method, the annals of Prussian agriculture contain details which we now transcribe. An oil of sufficiently good quality for successful employment in the lubrication of machinery, is manufactured at Moabit at the daily rate of 2,570 kilogrammes; its residue forming an excellent food for cattle. When

more or less finely ground, the latter may be sent off in sacks, and requires no pulverisation before being mixed with hard or soft water, but may be given to the animals at once, thus having an advantage over oil-cake. The oleaginous grain, such as colza, linseed, or mustard, arrives in ships by the Spree, and is raised into the warehouse by a perpetual screw, which every day draws up into the manufactory the necessary quantity for the work (about 33 hectolitres). It is then placed by a lift upon a sieve comprising a winnow, and thence falls, perfectly clean, into a triturator, the movements of whose cylinders are combined in such a way as to tear rather than bruise it.

After this preparation, the grain passes into a revolving cylinder of sheet iron, about 0.418 m. in diameter, and heated from below, whence it falls after desiccation into eight large vats, each holding 8.78 hectolitres, and capable of revolving on two horizontal axes.

After having carefully closed the vats with covers, the sulphide of carbon is conducted into them from a higher reservoir; about 7,000 kilos. being required for the daily manufacture, of which, however, only 28 kilos. are lost, that is to say about 4 per cent. From the bottom of the vat, the solution of oil in the sulphide of carbon trickles out in a thread-like manner, and becomes clearer, until at last the sulphide runs quite pure. This indicates the precise moment when the seed is completely deprived of oil, and steam is then substituted for the sulphide, of which it entirely removes all traces.

The vats are now uncovered and reversed, in order to eject the exhausted matter, which is taken up by the lifts and passed successively through three mill-hoppers heated by steam; lastly, it is again ground, when it forms an alimentary powder, containing 5.3 per cent of nitrogen, and saleable at 15.15 francs the hundred kilos. The mixture of oil and sulphide of carbon extracted from the vat washings is purified with steam, distilled twice, and cooled in three large worms passed through refrigerators. It is then rectified, which renders it capable of employment in new operations, after being restored to the original reservoir. The trade price of sulphide of carbon is from 0.79 fr. to 0.85 fr. the kilogramme, but costs the manufactory of Moabit rather less, as it is made on the premises. The oil thus obtained is sold as lamp oil after being deprived of colour; and by submitting it to a chemical process, a superior oil for purposes of lubrication is produced, possessing the advantage of being and remaining extremely fluid. Another oil is also manufactured, specially adapted to the lubrication of railway-carriage axles, inspissating at a very low temperature only. Four large wrought-iron reservoirs of 7.416 cubic metres each hold large quantities of oil, and a steam-engine of 12-horse power, with two boilers and a pressure of two atmospheres, give all the power and steam necessary for operation, transport, &c. The daily fabrication of 2,570 kilos. only requires the work of six men; and the careful analyses of M. Birner, of Regenwalde, and Karsten, of Kiel, could only find in the residue 2 per cent of oil and 7 per cent of water, whilst in the residue from the common method of pressing, 9 per cent of oil and 15 per cent of water were discovered.

The question has been much discussed as to whether colza oil-cake be a beneficial food for cattle; it depends on the object in view. The experience of M. Strengeld of Tharand proves that when cattle are young and have not attained their full growth, the colza oil-cake is advantageous, as the growth of animals requires food

richer in nitrogen and phosphoric acid than in fatty matter; it is also beneficial to milch cows. For fattening cattle, aliments richer in fatty matter are preferable. These remarks will explain the contradictory opinions held by different agriculturists.—(*Preussische Annalen der Landwirthschaft*.)

AIDE MEMOIRE FOR SILICEOUS FORMULÆ.

BY THE REV. B. W. GIBSONE, M.A.

NEGLECTING the recent classification by Odling of the silicates into ortho-, meta-, $\frac{3}{2}$, and acid, which distribution, though perhaps more philosophic, does not readily include some cases of common occurrence, we employ the well recognised formula—



This general type may be made to embrace almost all the known earthy silicates (however complicated their composition) by giving variations to its constants.

Here M denotes Ca'', Mg'', Fe'', Mn'', &c., or K₂, Na₂, metals furnishing a protoxide, and R stands for Fe'', Al'', Cr'', &c., metals furnishing a sesquioxide, the law of isomorphous substitution being supposed to prevail.

In every such formula five numerical constants—*p*, *q*, *r*, *s*, *t*—have to be recollected, a mental exertion almost intolerable even to those most versed in minerals; yet examiners (according to my personal experience) sometimes call upon examinees to write down half a dozen such in a single sitting.

While strongly deprecating such a deplorable misdirection of students' energies, I beg to submit to the latter a mode of surmounting much of the difficulty.

Abstract numbers may be represented by consonant letters, and these latter may then be grouped by aid of vowels into intelligible words having some relation obvious or fanciful to their original.

Thus, adopting Howlett's system of memoria technica, and calling—

s or x D	d or v 6
q or t 1	c or k 7
h or n 2	b or w 8
g or m 3	p or f 9
r or z 4	y 10
j or l 5	

such a long sequence of figures as 59221 might be recollected by the word *elephant*, or 92(10)75 by *physical*, the semiconsonant y being combined with the following consonant to form the symbol of any number from 10 to 19.

The following lines—some rational, some nonsensical—have stood the test of a few years' usage among my pupils, and contain the essentials worth remembrance, viz., the oxygen ratios of the constituents in the commonest natural siliceous compounds. In explanation I may add that the memorial words are italicised, and occur usually at the beginning or end of each verse.

Appended also are brief explanations designed to add intelligibility to a necessarily incoherent composition; they will, I diffidently hope, include some facts interesting to mineralogical students.

The atomic weights are the most recent.

Aluminous Silicates.

- (1). German calls Garnet Idocrase;
- (2). Man makes Staurolite; grain of clay's

- (3). (*O tedium di*) debris Felspar;
- (4). *Rare gaze to duped eyes* Micas are;
- (5). Heat Topaz and its tint will fade;
- (6). Of murder Scapolite's afraid
- (7). And gLucy Beryl sweet good maid,
- (8). Trapezal Leucite brings them aid,
- (9). But graver Epidote can't come;
- (10). Pol'd Tourmaline is set in gum.

(1). *Hausman* calls Vesuvian garnet idocrase; this, the pyramidal form, is isomeric with the dodecahedral or common garnet, $3\text{CaO}, 2\text{SiO}_2 + \text{Al}_2\text{O}_3, \text{SiO}_2$.

(2). Prismatic staurolite, $\text{Al}_2\text{O}_3, \text{SiO}_2$, has been formed artificially by Deville, who passed gaseous SiF_4 over alternate layers of Al_2O_3 and SiO_2 .

Kaolin or clay in its pure form (as got from St. Austell, Cornwall) $\text{Al}_2\text{O}_3, 2\text{SiO}_2 + 2\text{H}_2\text{O}$ is derived from the disintegration of Felspar by the weather.

(3). The felspars are a family *tedious* to enumerate; the member here quoted, potassium felspar or orthoclase, is monoclinic, the rest triclinic.

(4). The deceptive double refraction of the micas is of two kinds, viz., uniaxial in Mg mica, $4\text{MgO}, 2\text{SiO}_2 + \text{Al}_2\text{O}_3, 2\text{SiO}_2$ and biaxial in K mica, $\text{K}_2\text{O}, 3\text{SiO}_2 + 3\text{Al}_2\text{O}_3, 3\text{SiO}_2$.

(5). Topaz, according to Sir D. Brewster, contains an organic volatile hydrocarbon to which its colour is due. To a similar conclusion tend the researches of Lewy, Kuhlmann, Fournet in the case of other gems.

Topaz, $2\text{Al}_2\text{O}_3, 2\text{SiO}_2 + \text{Al}_2\text{O}_3, \text{SiF}_4$, contains a variable amount of fluorine, here estimated as equivalent, oxygen, viz., F, O_2 .

(7). Beryl, $3\text{GO}, 3\text{SiO}_2 + \text{Al}_2\text{O}_3, 3\text{SiO}_2$, is a source of glucinum and its *sweet* ($\gamma\lambda\kappa\upsilon\varsigma$) salts.

(8). The *trapezohedron*, a variety of the icositetrahedron, is named by Rose leucitohedron from this mineral's form.

(10). Tourmaline is eminently polar both electrically and optically; when used in the polariscope it may be mounted in Canada Balsam.

Hydrated Aluminous Silicates.

- (1). *Tune maiden* Analcime thy feeble lyre,
- (2). While Mesotype searches *the mart* for a buyer.
- (3). *Quid mi Dave!* see Stilbite's lustrous fire;
- (4). The zeolyte Prehnite *ne'er meant* to proclaim
- (5). *Them dead* to the fame of frail Chabazie's shame,
- (6). Nor that green-slate became for Chlorite *our home name*.

(1). Analcime (*αναλκις*, weak), named from its feeble electric power.

(2). Mesotype, formerly natrolite.

(3). Stilbite's *lustre* ($\sigma\tau\iota\lambda\beta\eta$) elicits the Latin exclamation of wonderment.

(5). Haüy terms this *fragile* and beautiful crystal chabazie.

(6). The *home* or trivial name of chlorite slate is green ($\chi\lambda\omega\pi\omicron\varsigma$) slate.

Magnesian Silicates.

- (1). *Hail* Talc, and in Magnesian group
- (2). *Gib* Steatite a part,
- (3). *Never smoke* Meerschaum, or the croup
- (4). Will hurt Picrosmine's heart.

(2).

- (5). Proud Augite, Pyroxene, Hypersthene *queen*
- (6). Has three titles, but Chrysolite Olivine none,
- (7). *Substitutive* ferruginous Serpentine green,

(8). And tough Amphibole, Hornblende will finish *lay one*.

(1). Talc, $4\text{MgO}, 5\text{SiO}_2$.

(3). Meerschaum, $2\text{MgO}, 3\text{SiO}_2 + 4\text{H}_2\text{O}$.

(4). Picrosmine ($\pi\iota\kappa\pi\omicron\varsigma$, pungent, $\sigma\sigma\mu\eta$, odour) has an argillaceous scent when moistened; several of this group also, e. g., steatite or soapstone, are unctuous to the touch.

(7). A trace of Fe replaces the Mg in serpentine, producing the deep green and red tints.

ON THE ACTION OF SULPHUROUS ACID ON COMPOUNDS OF SILVER.

BY PROFESSOR J. S. STAS.

I WILL give here, generally, the observations I have made on the action which sulphurous acid has upon silver compounds, according as the acid is intact or has undergone a decomposition.

A current of sulphurous anhydride, prepared by means of the combustion of sulphur in dry air, or by the decomposition of sulphuric acid by copper, mercury, carbon, or wood, produces a *white* precipitate of sulphite of silver in an aqueous solution of nitrate or sulphate of silver; the liquid remains colourless. A solution of sulphurous acid, newly obtained by passing the anhydride through boiled water, and *protected from the action of the light*, behaves like the anhydride. The sulphite of silver produced, kept from the light, seems to me to keep indefinitely at common temperatures; but under the influence of light, or of an excess of sulphurous acid, it changes into a mixture of sulphate of silver and metallic silver.

A current of sulphurous anhydride, or a fresh saturated aqueous solution of this anhydride does not precipitate sulphite of silver from a solution of nitrate or sulphate of silver, dissolved in water acidulated by a sufficient quantity of sulphuric or nitric acid; *the liquid remains colourless*. In complete darkness, the liquid may even be kept for a long time at 100°C , without the slightest precipitate or change of colour.

A solution of sulphurous acid in pure water, whether boiled or not, after being left for some time in the light, gives a *grey* precipitate with sulphate and nitrate of silver; in a few moments the supernatant liquid becomes successively yellow, brown, and black, and at length throws down sulphide of silver.

I have seen such a solution of altered sulphurous acid, precipitate, in darkness, metallic silver from a solution of nitrate or sulphate of silver in dilute sulphuric acid, and even in dilute nitric acid.

It is therefore seen that, under certain circumstances, a solution of sulphurous acid will act on nitrate and sulphate of silver as do most of the polythionic acids, which slowly precipitate sulphide of silver from solutions of these salts. H. Rose has already noticed that sulphurous anhydride obtained by the action of sulphur on binoxide of manganese, behaves in respect to soluble salts of silver differently from an acid produced by the reduction of sulphuric acid with mercury or copper, even after having deposited, by sufficient repose, the sulphur which it may have carried over. I have recognised the same fact, but in a less degree, with the sulphurous anhydride obtained by the action of sulphur on sulphuric acid. In fresh solution they both behave like very dilute solutions of pentathionic acid; they precipitate from nitrate of silver a mixture of sulphite, sulphate, and sulphide of silver.

The same difference which I have observed in the action of *intact* and *altered* sulphurous acid on nitrate and sulphate of silver dissolved in pure water or in water acidulated with sulphuric or nitric acid, I have observed in the reducing action which these intact or altered acids exert on the iodate, bromate, and chlorate of silver. At a low temperature, or in perfect darkness, both sulphurous anhydride and its solution, made at once away from the light, reduce to the state of iodide, bromide, and chloride the iodate, bromate, and chlorate of silver suspended in pure water or in water acidulated with sulphuric acid. Whatever may be the excess of sulphurous anhydride, or its solution, the pale yellow iodide, the bromide, still paler sometimes, and dark yellow at other times, and the white chloride remain absolutely intact, and all their elements remain insoluble for an indefinite time, if these compounds are absolutely withheld from direct or indirect solar radiation. We may even raise to 100° C., and keep for a long time at this temperature, the liquids in which the iodide, bromide, and chloride of silver rest by the side of the sulphurous acid, without their experiencing the least alteration.

The liquid in which the iodide, bromide, or chloride of silver is precipitated, contains no trace of iodhydric, bromhydric, or chlorhydric acid. On the other hand, under the influence of light and sulphurous acid, the iodide of silver, slowly becomes *greyish*, the bromide very rapidly becomes blackish, and the chloride very rapidly bluish black; in this case the liquids contain, respectively, iodhydric, bromhydric, and chlorhydric acids. When, in consequence of the presence of air, the sulphurous acid has passed to the state of sulphuric acid, the iodide of silver which had become *grey* regains its *yellow* colour, as the iodhydric acid brings it back to the state of iodide, and the iodide keeps yellow because it is unalterable by light alone, whilst the blackish bromide and the bluish black chloride preserve their altered condition. Bromhydric and chlorhydric acids cannot indeed pass to the state of bromine or chlorine under the influence of the atmospheric oxygen.

Sulphurous acid which has undergone spontaneous modification behaves quite differently with iodate, bromate, and chlorate of silver. Thus, in the most complete darkness, it transforms iodate of silver suspended in pure water or in water acidulated with sulphuric acid into orange iodide, and the iodide, after having been washed with water and treated with cyanide of ammonium mixed with cyanhydric acid, dissolves with separation of flocks of sulphur, and even of sulphide of silver, if the modification of the sulphurous acid is much advanced. In the most complete darkness, bromide of silver suspended in pure water, or in water acidulated with sulphuric acid, instantly passes to the state of yellow bromide under the influence of the modified sulphurous acid, and the mother liquor becomes coloured dark yellow, brown, black, and after becoming decolourised by standing, contains a notable quantity of bromhydric acid. The insoluble precipitate, first washed with water, and then treated with cyanide of ammonium and cyanhydric acid, leaves much residue of sulphide of silver.

Lastly, in the most perfect darkness, chlorate of silver dissolved in pure water or in water acidulated with sulphuric acid is changed, under the influence of modified sulphurous acid, to the state of chloride mixed with much sulphide of silver, the supernatant liquid containing much hydrochloric acid.

Thus, *intact* sulphurous acid exerts upon iodate,

bromate, and chlorate of silver a simple *reducing* action, whilst *modified* sulphurous acid exerts at the same time an action of *reduction* and of *sulphuration* similar to most of the polythionic acids.

ON THE SPECTRUM OF COMET II., 1868.*

BY WILLIAM HUGGINS, F.R.S.

THE author describes the appearance of the comet in the telescope on June 22 to consist of a nearly circular coma, which became rather suddenly brighter towards the centre, where there was a nearly round spot of light. A tail was traced for nearly a degree.

He found the light of the comet, when examined with a spectroscope, furnished with two prisms of 60°, to be resolved into three broad bright bands.

The brightest band commences at about *b*, and extends nearly to *r*. Another band begins at a distance beyond *r*, rather greater than half the interval between *b* and *r*. The third band occurs about midway between *p* and *e*. In the two more refrangible of these bands, the light was brightest at the less refrangible end, and gradually diminished towards the other limit of the bands. The least refrangible of the three bands did not exhibit a similar gradation of brightness.

These bands could not be resolved into lines, nor was any light seen beyond the bands toward the violet and the red.

The measures of these bands are given, and a diagram of their appearance.

The author found this cometic spectrum to agree exactly with a form of the spectrum of carbon which he had observed and measured in 1864. When an induction spark, with Leyden jars intercalated, is taken in a current of olefiant gas, the highly heated vapour of carbon exhibits a spectrum which is somewhat modified from that which may be regarded as typical of carbon. The light is of the same refrangibilities, but the separate strong lines are not to be distinguished. The shading, composed of numerous fine lines, which accompanies the lines, appears as an unresolved nebulous light.

On June 23 the spectrum of the comet was compared directly in the spectroscope with the spectrum of the induction spark taken in a current of olefiant gas.

The three bands of the comet appeared to coincide with the corresponding bands of the spectrum of carbon. In addition to an apparent identity of position, the bands in the two spectra were very similar in their general characters and in their relative brightness.

These observations were confirmed on June 25.

The remarkably close resemblance of the spectrum of the comet with that of the spectrum of carbon necessarily suggests the identity of the substances by which in both cases the light was emitted.

The great fixity of carbon seems, indeed, to raise some difficulty in the way of accepting the apparently obvious inference from these prismatic observations. Some comets have approached sufficiently near the sun to acquire a temperature high enough to convert even carbon into vapour.

In the case of other comets, the author suggests that the difficulty is one of degree only, for the conditions are not known under which even a gas permanent at the temperature of the earth could maintain sufficient heat to emit light.

* Abstract of a paper communicated to the Royal Society, July 2, 1868.

The author states that some phosphorescent substances give spectra which are discontinuous, but he gives reasons which would scarcely permit us to consider cometary light to be of a phosphorescent character.

The spectrum shows that the colour of this comet was bluish green. Considerable difference of colour has been remarked in the parts of some comets. Sir William Herschel described the head of the comet of 1811 to be of a greenish or bluish-green colour, while the central point appeared of a ruddy tint. The same colours have been observed in other comets. If carbon be the substance of some comets, this substance, if incandescent in the solid state, or reflecting, when in a condition of minute division, the light of the sun, would afford a light which, in comparison with that emitted by the luminous vapour of carbon, would appear yellowish or approaching to red.

The author refers to the bearing of these results on certain cometary phenomena, and on the apparent identity of the orbits of the periodical meteors with those of some comets.

LIQUID GLUE.

BY M. KNAFFL.

This useful article, which is employed for a variety of purposes, as mending porcelain, glass, mother-of-pearl, &c., is not nearly so good when prepared with vinegar and nitric acid as that obtained by the following process:—Three parts of glue broken into small pieces should be covered with eight parts of water, and left to stand for some hours; one-half of chlorhydric acid and three-fourths of sulphide of zinc must then be added, and the whole exposed to a temperature of from 81° to 89° C., during ten or twelve hours. The compound thus obtained does not gelatinise; it only needs to be allowed to settle, and will be found a most useful agent for joining purposes.—(*Wochenschrift des Nieder-österreichischen Gewerbevereins*).

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

NORWICH MEETING, WEDNESDAY, AUGUST 19, 1863.

INAUGURAL ADDRESS OF THE PRESIDENT,

JOSEPH DALTON HOOKER, ESQ., F.R.S., D.C.L.,

DIRECTOR OF THE ROYAL GARDENS, KEW.

MY LORDS, LADIES, AND GENTLEMEN:—Thirty years will to-morrow have elapsed since I first attended a meeting of the British Association; it was the one which opened at Newcastle on the 20th of August, 1838. On that occasion the Council of the Association resolved to recommend to Her Majesty's Government the despatch of an expedition to the Antarctic regions, under the command of Captain James Rep; and it was from Newcastle that I wrote to my friends announcing my resolve to accompany it in whatever capacity I could obtain a situation amongst its officers. It was thus that my scientific career was first shaped; and it is to this expedition, which was one of the very earliest results of the labours of the British Association, that I am indebted for the honour you have conferred upon me in placing me in your President's chair.

If I now look back with pride to those immediately following years, when I had a share, however small, in the discovery of the Antarctic Continent, the Southern Magnetic Poles, the Polar Barrier, and the Ice-clad Volcanoes of Niterie Land, I do so also with other and far different feelings. Thirty

years, as statisticians tell us, represent the average duration of a human life; I need not say, that as measured by the records of this British Association, a human lifetime is far shorter than this; for of the fourteen officers who presided over us in 1838 but two remain—your former President and devoted adherent for thirty-five years, Sir Roderick Murchison, who delivered the opening address on that occasion, and whose health, I regret to add, prevents his attendance at this meeting; and your faithful and ever-green Secretary, Professor Phillips, upon whose presence here I congratulate both you and him.

Again, looking back beyond thirty years ago, in the pages of your records I find those to have been halcyon years for Presidents when the preparation and delivery of the addresses devolved upon the Treasurer, Secretary, or other officers than the President; and that in fact presidential addresses date from the first meeting after that at Newcastle. Of late years these addresses have been regarded, if not as the whole duty of the President, certainly as his highest; for your sakes, as well as for my own, I wish this were not so, both because there are amongst your officers so many men far more competent than I am, and because I believe that the responsibility which the preparation of these addresses entails, limits disadvantageously your choice of Presidents. The impression is very prevalent that the address should either be a scientific *tour de force*, philosophical and popular, or a *resumé* of the progress of one or more important branches of science; and this view of the duty has greatly embarrassed me, inasmuch as I am unable to fulfil either of these requirements. On various occasions during the last half-year I have essayed to fulfil the wishes of my botanical friends, that I should either discuss the phenomena of the vegetable kingdom in their relation to collateral sciences, or sketch the rise and progress of Scientific Botany during the present century, or a portion of it; but every such essay has been quickly frustrated by the pressure of official duties. Such themes require much research, much thought, and, above all, some continuous leisure, during which the whole mind may be concentrated on the method of treatment, as well as upon the material to be treated of; and this leisure was incompatible with the discharge of my duties as administrator of a large public department, entailing a ceaseless correspondence with the Government offices and with botanical establishments all over the globe. And I do not ask your indulgence for myself alone, for there are at this meeting official men of scientific attainments, who have accepted the presidentships of sections, but who, on leaving their posts to do your bidding, drag a lengthening chain of correspondence after them, and sacrifice no short portion of those brief holidays which are allowed to public officers. After all, it is deeds, not words, that we want from them; and I am proud to find our sections presided over by men who have won their spurs in their respective sciences, and who will wear them in the chairs they occupy, and use them too, if needs must.

For my own part I propose to offer you some remarks upon several matters to which the attention of your Council was directed when at Dundee—and then upon some of the great advances that have been made in Botany during the last few years—this will infallibly drag me into Darwinism; after which I shall allude to some matters connected with that dawning science, the Early History of Mankind, a theme which will be a distinguishing collateral feature of the Norwich Association. If in all this I disappoint you, it will be my solace to hope that I may thereby break the fall of some future President, who, like myself, may have all the will, but not the time, adequately to meet your great expectations.

Before commencing, however, I must attend to a circumstance which cannot but be uppermost in the minds of all habitual attendants at these annual gatherings—it is, that but for a severe accident, there would have been present here to-night the oldest surviving, and indeed the first but two of the Presidents of the British Association; my geological friends will understand to whom I allude, as that Rock of Science in whom age and the heat and shocks of scientific controversy

have wrought no metamorphosis, and developed no cleavage planes—a man of whom both Norwich and the Association are proud—your Canon, our father, Sedgwick.

My first duty as President is the pleasant one of introducing to you the members of the International Congress of Pre-historic Archaeology, who, under the presidency of Sir John Lubbock, himself a master of this branch of knowledge, open their third session to-morrow in this city. The researches which specially occupy the attention of the Congress, are perhaps the most fascinating that ever engaged the faculties of man; and pursued as they now are in a scientific spirit, and in due subjection to scientific methods, they will command all the sympathy, and their meetings will receive all the support that my fellow members of the British Association can afford to them. And there is one way in particular by which we can show our goodwill and give our support,—and it is so simple that I hope no one will neglect it,—and that is, that we shall all call at their official residence at the Free Library, inscribe our names in their books, and obtain cards for their meetings.

The next subject which I have to bring officially before you will interest the members of the Congress no less than ourselves, and relates to the action of a committee which your Council appointed, to represent to the Secretary of State for India "the great and urgent importance of adopting active measures to obtain reports on the physical form, manners, and customs of the indigenous populations of India, and especially of those tribes which are still in the habit of erecting Megalithic monuments."

Upon consideration, the committee decided that it would be better in the first instance, to direct the attention of the Secretary of State to the last-mentioned tribes only, both because the whole enquiry was so vast, and because systematic efforts are now being made by the Indian Government to obtain photographs and histories of the native Indian tribes. Their efforts are, as regards the photographs obtained in India, eminently successful, which renders it all the more disappointing that the descriptive matter appended to them in this country, and which is happily anonymous, is most discreditable to the authority under which it is issued.

It will, no doubt, surprise many here to be told that there exists, within 300 miles of the British capital of India, a tribe of semi-savages who habitually erect dolmens, men-ares, cysts, and cromlechs, almost as gigantic in their proportions, and very similar in appearance and construction, to the so-called Druidical remains of Western Europe; and what is still more curious, though described and figured nearly a quarter of a century ago by Col. Yule, the eminent Oriental geographer, except by Sir John Lubbock, they are scarcely alluded to in the modern literature of pre-historic monuments. In the *Bengal Asiatic Journal* for 1844, you will find Col. Yule's description of the Khasia people of East Bengal, an Indo-Chinese race, who keep cattle but drink no milk, estimate distances traversed by the mouthfuls of *pawn* chewed *en route*, and amongst whom the marriage tie is so loose, that the son commonly forgets his father, when the sister's son inherits property and rank. Dr. Thomson and I dwelt for some months amongst the Khasia people, now eighteen years ago, and found Col. Yule's account to be correct in all particulars. The undulatory eminences of the country, some 4,000 to 6,000 feet above the level of the sea, are dotted with groups of huge unpolished squared pillars and tubular slabs, supported on three or four rude piers.

In one spot, buried in a sand grove, we found a nearly complete circle of menhies, the tallest of which was 30 feet out of the ground, 6 feet broad, and 2 feet 8 inches thick; and in front of each was a dolmen or cromlech of proportionately gigantic pieces of rock, whilst the largest slab hitherto measured is 32 feet high, 15 feet broad, and 2 feet thick.

Several that we saw had been very recently erected, and we were informed that every year some are put up, but not in the rainy season, which we spent in the country.

The method of removing the blocks is by cutting grooves, along which fires are lit, and into which, when heated, cold water is run, which causes the rock to fissure along the groove; the lever and rope are the only mechanical aids used in transporting and erecting the blocks. The objects of their erection are various—sepulture, marking spots where public events had occurred, &c. It is a curious fact that the Khasian word for a stone, "Man," as commonly occurs in the names of their villages and places, as that of Man, Macn, and Men, does in those of Brittany, Wales, Cornwall, &c.; thus Mansmai signifies in Khasia the Stone of Oath—Mamloo, the Stone of Salt—Manfong, the Grassy Stone; and, just as in Wales, *Per mawr mawr* signifies the Hill of the Big Stone; and in Brittany a *Maculhyr* is a Standing Stone, and a *Dolmen* a Table Stone, &c.

At the date of Colonel Yule's, as of my visit to these people, our intercourse with them was limited, and not always friendly; we were ignorant of their language, and they themselves far from communicative. Of late, however, the country has been more opened up, and the establishment of a British cantonment amongst them renders it all the more important that the inquiry into their origin, language, beliefs, customs, &c., should be followed up without delay. This will now be done, thanks to your representations, and I cannot doubt but that it will throw great light upon that obscure and important branch of Pre-historic Archaeology, the Megalithian monuments of Western Europe.

The Council of the Association, upon the recommendation of the Biological Section, appointed a committee to report upon the subject of the government of the Natural History collections of the British Museum, which resulted in a deputation, who represented to the Prime Minister, in the name of the Council;—that it was desirable that these collections be placed under the control of a single officer, who should be directly responsible to a Minister of the Crown; and that this opinion was shared by an overwhelming majority of British naturalists. The reasons stated were, that there appeared no reason why the national collections of Natural History should be administered in a way different from that which was found applicable to the Royal Gardens and Botanical collections at Kew, the Museum of Practical Geology, and the Royal Observatory at Greenwich,—and that the interposition of any board or committee between the superintendent of the collections and the Government must interfere with the responsibility of the superintendent and the efficient control of the Minister.

It was not for the first time that this subject had been brought before Her Majesty's Government, and indeed before the self-same Prime Minister; for, ten years previously a few naturalists, consisting of Messrs. Benthall, Bush, Darwin, Huxley, Dr. Carpenter, and myself, together with the late Professors Lindley, Henslow, Harvey, and Huxley, presented a memorial to Mr. Disraeli, then, as now, Prime Minister, embodying precisely the same views as to the government of the Natural History Department of the British Museum, together with a scheme for the administration of the whole Metropolitan Natural History collection, Geological and Botanical; and I have only to add, regarding this document, that the surviving memorialists have not, during the ten intervening years, found reason to alter the views therein expressed on any vital point.

Of the objections to the present system of government by trustees, some of the most grave have been stated by Mr. Andrew Murray in a communication[†] made to the Biological Section at Dundee; to which I would only add, that though the Zoological collections are the finest in the world, and the Geological and Palaeontological of prodigious extent and value, there are, of the forty-five trustees, only three who have any special knowledge whatsoever of the branches of science these collections illustrate; that since

* Report for 1867. Transactions of Sections, p. 95.

Sir Joseph Banks' death, nearly half a century ago, no botanist has ever been appointed a trustee, though the Banksian Herbarium and Botanical Library, then amongst the most valuable in Europe, were left by their owner to the nation, and, in fine, that the interests of Botany have, by their trustees, been greatly neglected.

Much as has been written upon the uses of museums, I believe that the subject is still far from being exhausted, for, in the present state of education in this country, these appear to me to afford the only means of efficiently teaching to schools the elements of Zoology and Physiology. I say in the present state of education, because I believe it will be many years before we have schoolmasters and schoolmistresses trained to teach these subjects; and many more years before either provincial or private schools will be supplied with such illustrative specimens as are essential for the teacher's purposes.

Confining myself to the consideration of provincial and local museums, and their requirements for educational purposes, each should contain a series of specimens illustrating the principal and some of the lesser divisions of the animal and vegetable kingdoms, so disposed in well-lighted cases as that an inquiring observer might learn therefrom the principles upon which animals and plants are classified, the relations of their organs to one another and to those of their allies, the functions of those organs; and other matters relating to their habits, uses, and place in the economy of nature. Such an arrangement has not been carried out in any museum known to me, though partially attained in that at Ipswich; it requires some space, many pictorial illustrations, magnified views of the smaller organs and their structure, and copious legible descriptive labels, and it should not contain a single specimen more than is wanted. The other requirements of a provincial museum are, complete collections of the plants and animals of the province, which should be kept entirely apart from the instructional series, and from everything else.

The curator of the museum should be able to give elementary demonstrations (not lectures, and quite apart from any powers of lecturing that he may possess) upon this classified series, to schools and others, for which a fee should be charged and go to the support of the institution. And the museum might be available (under similar conditions of payment) for lectures and other demonstrations.

Excellent manuals of many branches of Geology are now published, which are invaluable to the advanced student and demonstrator; but from which the schoolboy recoils who would not refuse to accept objects and pictures as memory's pegs on which to hang ideas, facts, and hard names. To schoolboys, skeletons have often a strange fascination, and upon the structure of these and the classification of the vertebrata much depends. What boy that had ever been shown their skulls would call a seal or porpoise a fish, or believe a hedgehog could milk cows? as I am told many boys in Norfolk and Suffolk (as elsewhere) do believe implicitly.

A series of illustrated specimens, occupying some 5,800 feet of wall space, would give at a glance a connected and intelligible elementary view of the classification and structure of the whole animal kingdom, it would stand in the same relation to a complete museum and *systema naturæ*, as a chart on which the principal cities and coast-lines are clearly laid down, does to a map crowded with undistinguishable details.

Much of the utility of museums depends on two conditions often strangely overlooked, viz., their situation and their lighting and interior arrangements. The provincial museum is too often huddled away almost out of sight in a dark, crowded, and dirty thoroughfare, where it pays dear for ground-rents, rates, and taxes, and cannot be extended; the object, apparently, being to catch country people on market days. Such localities are frequented by the townspeople only when on business, and when they consequently have no time for sight-seeing. In the evening, or on holidays, when they could visit the museum, they naturally prefer the outskirts of the town to its centre.

Hence, too, the country gentry scarcely know of the museum's existence; and I never remember to have heard of a provincial museum that was frequented by schools, but rather the contrary. I do not believe that this arises from indifference to knowledge on the part of the upper classes or of teachers, but to the generally uninteresting nature of the contents of these museums, and their uninviting exterior and interior.

There are plenty of visitors of all classes to the museums at Kew, despite the outer attractions of the gardens, and I know no more pleasing sight than these present on a Sunday and Monday afternoon, when crowded by intelligent visitors, directing their children's attention to the ticketed objects in the cases.

The museum should be in an open grassed square or park, planted with trees, in, or in the outskirts of, the town, a main object being to secure cleanliness, a cheerful aspect, and space for extension. Now, vegetation is the best interceptor of dust, which is injurious to the specimen as well as unsightly, whilst a cheerful aspect and grass and trees will attract visitors, and especially families and schools.

If the external accessories of provincial museums are bad, the internal are often worse; the rooms are usually lighted by windows on one side only, so that the cases between the walls are dark, and those opposite the window reflect the light when viewed obliquely, and when viewed in front the visitor stands in his own light. For provincial museums, when space is an object, there is no better plan than the rectangular long rooms, with opposite windows on each side, and buttress cases projecting into the room between each pair of windows. This arrangement combines economy of space with perfect illumination, and affords facilities for classification.

In respect of its Natural History collections the position of the British Museum appears to me to be a disadvantageous one; it is surrounded by miles of streets, including some of the principal Metropolitan thoroughfares, which pour clouds of dust and the product of coal combustion into its area day and night; and I know few more disappointing sights to me than this badly-lighted interior presents on a hot and crowded public holiday, when whole families from London and its outskirts flock to the building. Then young and old may be seen gasping for fresh air in its galleries, with no alternative but the hotter and dustier streets to resort to. How different it would be were these collections removed to the toward end of one of the great parks? where spacious and well-lighted galleries could be built, amongst trees, grass, and fountains; and where whole families need not any more be cooped up for the day in the building, but avail themselves of the fresh air and its accessories at the same time as they profit by the collection.

My remarks on the British Museum convey no reflection on the able officers who have, in so short a time, formed this wonderful collection. The late Mr. Lawrence, in his lecture in 1815, congratulates his audience on the formation of a zoological collection having been just determined upon;—in 1838, when I first knew the Museum in Old Montague House, I was told it ranked about the sixth in Europe—now, and for some years past, it has been considered to be the finest in the world. This is due to the energy and ability of the keepers and curators, and, in mentioning them, I would wish to pay a passing tribute to the merits of the venerable Dr. Gray, who has devoted his life to the development of the Zoological department with a singleness of purpose, liberality, and zeal that are beyond all praise.

At the time when Old Montague House contained the National Collections, there was but one museum in the Metropolis in which the naturalist could study to much purpose: this was the Hunterian (of the Royal College of Surgeons), then under the superintendence of the late Mr. Clift and of Professor Owen, the friend of my early youth, when preparing myself to accompany the Antarctic Expedition, and who instructed me in the use of that now unrivalled series of catalogues that owed so much to himself. From the Museum of the Royal College of Surgeons, the national and provincial

museums of England have much to learn and to copy, and thanks to the wisdom and munificence of the council of the college, and to the zeal and ability of the present conservator, Mr. Flower, it retains the position it attained thirty years ago, of being the best and richest institution of the kind in Europe.

In my own special science the greatest advances that have been made during the last ten years have been in the departments of Fossil Botany, and Vegetable Physiology.

In the past history of the globe, two epochs stand prominently out—the carboniferous and the miocene—for the abundant material they afford, and the light they consequently throw on the early conditions of the vegetable kingdom. Why plants should have been so much more lavishly preserved during these than during some of the intervening or earlier epochs we do not rightly know; but the comparative poverty of the floras of these latter is one amongst the strongest evidences of the imperfection of the Geological record.

Our knowledge of coal plants, which, since the days of Sternberg, Brongniart, and Lindley and Hutton, has been chiefly advanced by Goppert and Unger on the Continent, and by Dawson in Canada, has received very important accessions of late through the untiring energy of Mr. Binney of Manchester, who has devoted nearly thirty years to the search for those rarely found specimens which exhibit the internal structure of the plant. His elaborate descriptions of the most abundant, and, till his researches, the least understood plant of the coal measures, *Calamites*, has just appeared in the memoirs of the Palaeontographical Society; and some of Mr. Binney's materials having also formed the subject of a very recent and valuable paper by Mr. Carruthers, of the British Museum, I may quote their joint results as one. These show that *Calamites* is an actual member of the existing family of Equisetaceae, which contained previously but one genus, that of the common mare's tails of our riverbanks and woods; as also, that nearly a dozen other genera of coal measures plants may be referred to it. This affinity of *Calamites* had, indeed, been guessed at before, and the genera now referred to it, having been founded on mere fragments, were always doubtful; but the value of these positive identifications is none the less on these accounts. It may hereafter prove of some significance that these *Calamites*, which, in the coal epoch assumed gigantic proportions, and presented multitudinous forms and very varied organs of growth, are now represented by but one genus, differing most remarkably from its prototype in size and the simplicity and uniformity of its vegetable organs.

Passing to the tertiary times, the labours of Count Sapperta in France, of Gaudin and Strozzi, and of Massolungli in Italy, of Lesquereux in America, and above all of Heer in Switzerland, have within the last ten years accumulated vast numbers of species of fossil plants, and if the determination of the affinities of the majority are dependable, they prove the persistence throughout the tertiary strata of many interesting families and genera, and the rarity of others than these. Here, however, much value cannot be attached to negative evidence. Almost the only available materials for determining the affinities of the vast majority of these tertiary plants are their mutilated leaves, and, unlike the bones of vertebrate animals, and the shells of molluscs, the leaves of individual plants are extremely variable in all their characters. Furthermore, the leaves of plants of different natural families, and of different countries, mimic one another to such a degree, that in the case of recent flowers, every botanist regards these organs as most treacherous guides to affinity. Of the structural characters which are drawn from the internal organs of plants, and especially from their fruit, seeds, and flowers, few traces are to be found in the fossils, and yet it is from them exclusively that the position of a recent plant in the vegetable kingdom can be certified. An instructive instance of over-reliance on leaves, and perhaps, too, on unperceived ideas, happened not long ago to a palaeontologist of such distinguished merit that his reputation cannot suffer from an allusion to it. In the course of his labours over

some imperfect specimen from a most interesting locality, he referred these associated impressions of fossil leaves to three genera, belonging to as many different families of plants, and was thus helped to what would have been some important conclusions as to the vegetation of the period in which they were deposited. A subsequent observer, who was a botanist but not a palaeontologist, declares these three supposed genera to be the three leaflets of one leaf of one plant, and this the common blackberry, which still grows on the spot. Which of the two is right, I do not say; the fact shows to what opposite conclusions different observers of the same fossil materials may be led.

In this most unreliable of sciences—Fossil Botany—we do but grope in the dark; of the thousands of objects we stumble against, we here and there recognise a likeness to what we have elsewhere known, and rely on external similitude for a helping hand to its affinities; of the great majority of specimens we know nothing for certain, and of no small proportion we are utterly ignorant.

If, however, much is uncertain, all is not so, and the science has of late made sure and steady progress, and developed really grand results. Heer's labours on the miocene and pliocene floras especially are of the highest value and interest; his conclusions regarding the flower of the Bovey Tracy coal beds (for the publication of which, in a form worthy of their value and of their author's merit, we are indebted to the wise liberality of Miss Burdett Coutts) are founded on a sufficient number of absolute determinations; and his more recent *Flora Fossilis Arctica*, threatens to create a revolution in Tertiary Geology. In this latter work, Professor Heer shows, on apparently unassailable evidence, that forests of Austrian, American, and Asiatic trees flourished during miocene times in Iceland, Arctic Greenland, Spitzbergen, and the Polar American Islands, in latitudes where such trees could not now exist under any conceivable conditions or positions of land, or sea, or ice, and leaving little doubt but that an arboreal vegetation once extended to the Pole itself. Discoveries such as these appear at first actually to retard the progress of science, by confounding all previous geological reasoning as to the climate and condition of the globe during the tertiary epoch.

I have said that the greatest botanical discoveries made during the last ten years have been physiological, and I here alluded especially to the series of papers on the "Fertilisation of Plants," which we owe to Mr. Darwin. You are aware that this distinguished naturalist, after accumulating stores of facts in Geology and Zoology during his circumnavigation of the globe with Captain Fitzroy, espoused the doctrine of the continuous evolution of life, and by applying to it the principles of natural selection, evolved his theory of the origin of species. Instead of publishing these views as soon as conceived, he devoted twenty more years to further observation, study, and experiment, with the view of maturing or subverting them. Amongst the subjects requiring elucidation or verification were many that appertained to Botany, but which had been overlooked or misunderstood by botanical writers, and these he set himself to examine vigorously.

The first fruits of his labours was his volume on the "Fertilisation of Orchids," undertaken to show that the same plant is never continuously fertilised by its own pollen, and that there are special provisions to favour the crossing of individuals. As his study of the British species advanced, he became so interested in the number, variety, and complexity of the contrivances he met with that he extended his survey to the whole family, and the result is a work of which it is not too much to say that it has thrown more light upon the structure and functions of the floral organs of this immense and anomalous family of plants than had been shed by the labours of all previous botanical writers. It has, further, opened up entirely new fields of research, and discovered new and important principles that apply to the whole vegetable kingdom.

This was followed by his paper on the two well-known

forms of the primrose and cowslip,* popularly known as the pin-eyed and the thrum-eyed; these forms he showed to be sexual and complementary; their diverse functions being to secure, by their mutual action, full fertilisation, which he proved could only take place through insect agency. In this paper he established the existence of homomorphic, or legitimate and heteromorphic, or illegitimate unions amongst plants, and details some curious observations in the structure of the pollen. The results of this, perhaps more than any other of Mr. Darwin's papers, took botanists by surprise; the plants being so familiar, their two forms of flower so well known to every intelligent observer, and his explanation so simple. In myself I felt that my botanical knowledge of these homely plants had been but little deeper than Peter Bell's, to whom

A primrose by the river's brim
A yellow primrose was to him,
And,—it was nothing more.

Analogous observations on the dimorphism of flax-flowers and their allies,† formed the subsequent paper, during which he made the wonderful discovery that the common flax, the pollen of one form of flower, is absolutely impotent when applied to its own stigma, but invariably potent when applied to the stigma of the other form of flower; and yet both pollens and stigmas of the two kinds are utterly undistinguishable under the highest powers of the microscope.

His third investigation is a very long and laborious one on the common loose-strife,‡ (Lythrum salicaria), which he showed to be trimorphic, this one species having three kinds of flowers, all annually abundantly produced, and as different as if they belonged to different species; each flower has, further, three kinds of stamens, differing in form and function. We have in this plant, then, six kinds of pollen, of which five at least are essential to complete fertility, and three distinct forms of style. To prove these various differences, and that the co-adaptation of all these stamens and pistils was essential to complete fertility, Mr. Darwin had to institute eighteen sets of observations, each consisting of twelve experiments, 216 in all. Of the labour, care, and delicacy required to guard such experiments against the possibility of error, those alone can tell who know experimentally how difficult it is to hybridise a large flowered plant of simple form and structure. The results in this case, and in those of a number of allied plants experimented on at the same time, is what the author's sagacity predicted; the *rationale* of the whole was demonstrated, and he finally showed, not only how nature might operate in bringing these complicated modifications into harmonious operation, but how through insect agency she does do this, and why she does it too.

It is impossible even to enumerate here the many important generalisations that have flowed from these and other papers of Mr. Darwin's on the fertilisation of plants; some that appear to be commonplace at first sight are really the most subtle, and, like many other apparent commonplaces, are what, somehow, never occur to commonplace minds: as, for instance, that all plants with conspicuously coloured flowers, or powerful odours, or honeyed secretions, are fertilised by insects; all with inconspicuous flowers, and especially such as have pendulous anthers, or incoherent pollen, are fertilised by the wind; from whence he infers that, before honey-feeding insects existed, the vegetation of our globe could not have been ornamented with bright-coloured flowers, but consisted of such plants as pines, oaks, grasses, nettles, &c.

The only other botanical paper of Mr. Darwin's to which I can especially allude, is that "On the Habits and Movements of Climbing Plants,"§ which is a most elaborate investigation into the structure, modification, and functions of the various organs by which plants climb, twine, and

attract themselves to foreign objects. In this he reviews every family in the vegetable kingdom, and every organ used by any plant for the above purpose. The result places the whole subject in a totally new light before us. The guesses, crude observations, and abortive experiments that had disfigured the writings of previous observers are swept away; organs, structures, and functions of which botanists had no previous knowledge are revealed to them, and the whole investigation is made as clear as it is interesting and instructive.

The value of these discoveries, which add whole chapters to the principles of Botany, is not theoretical only: already the horticulturist and agriculturist have begun to ponder over them, and to recognise in the failure of certain crops the operation of laws that Mr. Darwin first laid down. What Faraday's discoveries are to telegraphy Mr. Darwin's will assuredly prove to rural economy, in its widest sense and most extended application.

Another instance of successful experiment in Physiological Botany is Mr. Herbert Spencer's observations on the circulation of the sap and formation of wood in plants.* As is well known, the tissues of our herbs, shrubs, and trees, from the tips of their roots to those of their petals and pistils, are permeated by tubular vessels. The functions of these have been hotly disputed, some physiologists affirming that they convey air, others fluids, others gases, and still others assigning to them far-fetched uses of a wholly different nature. By a series of admirably contrived and conducted experiments, Mr. Spencer has not only shown that these vessels are charged at certain seasons of the year with fluid, but that they are intimately connected with the formation of wood. He further investigates the nature of the special tissues concerned in this operation, and shows not merely how they may act, but to a great extent how they do act. As this paper will, I believe, be especially alluded to by the President of the Biological Section, I need dwell no further on it here than to quote it as an example of what may be done by an acute observer and experimentalist, versed in Physics and Chemistry, but above all thoroughly instructed in scientific methods.

Mr. Darwin's recent two volumes "On Animals and Plants under Domestication," is a catacomb of data, observations, and experiments such as assuredly no one but himself could produce. It is hard to say whether it is most remarkable for the number and value of the new facts it discloses, or for its array of small forgotten or overlooked observations, neglected by some naturalists and discarded by others, which, under his mind and eye, prove to be of first-rate scientific importance. An eminent surgeon and physiologist (Mr. James Paget) has remarked to me, *apropos* of these volumes, that they exemplify in a most remarkable manner that power of utilising the waste materials of other scientific men's laboratories, which is a very characteristic feature of their author. As one of those pieces justificative of his previous work, "The Origin of Species," which have been waited for so long and impatiently, these volumes will probably have more than their due influence, for the serried ranks of facts in support of his theories which they present may well awe many a timid naturalist into bolting more obnoxious doctrines than that of natural selection.

It is in this work that Mr. Darwin expounds his new hypothesis of pangenesis, which certainly correlates, and may prove to contain the *rationale* of all the phenomena of reproduction and of inheritance. You are aware that every plant or animal commences its more or less independent life as a single cell, from which is developed an organism more or less closely similar to its parents. One of the most striking examples I can think of is afforded by a species of Begonia, the stalks, leaves, and other parts of which are superficially studded with loosely attached cells. Any one of those cells, if referred to favourable conditions, will produce a perfect plant, similar to its parent. You may say that these cells have inherited the potentiality to do so, but

* Journal of the Linnean Society, vol. vi., p. 77.

† Journal of the Linnean Society, vol. vii., p. 69.

‡ Ibid., vol. viii., p. 169.

§ Ibid., vol. ix., p. 1.

* "Linnean Transactions," vol. xxv., p. 405.

this is not all, for every plant thus produced in like manner, develops on its stalks leaves and myriads of similar cells, endowed with the same property of becoming such in new plants; and so on, apparently interminably. Therefore the original cell that left the grandparent, not only carried with it this so-called potentiality, but multiplied it and distributed it with undiminished power through the other cells of the plant itself produced; and so on, for countless generations. What is this potentiality, and how is this power to reproduce thus propagated, so that an organism can, by single cells, multiply itself so rapidly, and within very narrow limits, so surely and so interminably? Mr. Darwin suggests an explanation, by assuming that each cell or fragment of a plant (or animal) contains myriads of atoms or geminules, each of which geminule he supposes to have been thrown off from the separate cells of the mother-plant, the geminules having the power of multiplication, and of circulating throughout the plant; their future development, he supposes to depend on their affinity for other partially developed cells in due order of succession. Geminules which do not become developed may, according to his hypothesis, be transmitted through many succeeding generations, thus enabling us to understand many remarkable cases of reversion or atavism. Thus, according to this hypothesis, not only have the normal organs of the body, the representative elements of which they consist, diffused through all the other parts of the body, but the morbid states of these, as hereditary diseases, malformations, &c., all actually circulate in the body as morbid geminules.

As with other hypotheses based on the assumed existence of structures and elements that escape our senses by reason of their minuteness or subtlety, this of pangenesis will approve itself to some minds and not to others. To some these inconceivably minute circulating geminules will be as apparent to the mind's eye as the stars of which the milky way is composed; others will prefer embodying the idea in such a term as potentiality, a term which conveys no definite impression whatever, and they will like it none the less on this account.

Whatever be the scientific value of these geminules, there is no question but that to Mr. Darwin's enunciation of the doctrine of pangenesis we owe it, that we have the clearest and most systematic *resumé* of the many wonderful phenomena of reproduction and inheritance that has yet appeared; and against the guarded entertainment of the hypothesis, on speculation if you will, as a means of correlating these phenomena, nothing can be urged in the present state of science. The president of the Linnean Society, a proverbially cautious naturalist, thus well expresses his own ideas of pangenesis: "If," he says, "we take into consideration, how familiar mathematical signs and symbols make us with numbers and combinations, the actual realisation of which is beyond all human capacity, how inconceivably minute must be those emanations which most powerfully affect our sense of smell and our constitutions; and if, discarding all preventions, we follow Mr. Darwin, step by step, in applying his suppositions to the facts set before us, we must, I think, admit that they may explain some, and are incompatible with others; and it appears to me that pangenesis will be admitted by many as a provincial hypothesis, to be further tested, and to be discarded only when a more plausible one shall be brought forward."

Ten years have elapsed since the publication of "The Origin of Species by Natural Selection," and it is therefore not too early now to ask what progress that bold theory has made in scientific estimation.

The most widely-circulated of all the journals that give science a prominent place on their title-pages—the *Athenæum*—has very recently told to every country where the English language is read, that Mr. Darwin's theory is a thing of the past, that natural selection is rapidly declining in scientific favour, and that, as regards the above two volumes on the variations of animals and plants under domestication, they "contain nothing more in support of origin by selec-

tion than a more detailed reassembling of his guesses founded on the so-called variations of pigeons."

Let us examine for ourselves into the truth of these inconsistent statements.

Since the "Origin" appeared, ten years ago, it has passed through four English editions, two American, two German, two French, several Russian, a Dutch, and an Italian; whilst of the work on variation, which first left the publisher's house not seven months ago, two English, a German, Russian, American, and Italian editions are already in circulation. So far from natural selection being a thing of the past, it is an accepted doctrine with almost every philosophical naturalist, including, it will always be understood, a considerable proportion who are not prepared to admit that it accounts for all Mr. Darwin assigns to it.

Reviews on "The Origin of Species" are still pouring in from the continent, and Agassiz, in one of the addresses which he issued to his *collaborateurs* on their late voyage to the Amazons, directs their attention to this theory as a primary object of the expedition they were then undertaking. I need only add, that of the many eminent naturalists who have accepted it, not one has been known to abandon it; that it gains adherents steadily, and that it is, *par excellence*, an avowed favourite with the rising schools of naturalists; perhaps, indeed, too much so, for the young are apt to accept such theories as articles of faith, and the creed of the student is but too likely to become the shibboleth of the future professor.

The scientific writers who have publicly rejected one or both of the theories of continuous evolution and of natural selection, take their stand upon physical or metaphysical grounds, or both. Of those who rely on the metaphysical, their arguments are usually strongly imbued with theological prejudice and even odium, and, as such, are beyond the pale of scientific criticism. Having myself been a student of moral philosophy in a northern university, I entered on my scientific career full of hopes that metaphysics would prove a useful mentor, if not a guide in science. I soon, however, found that it availed me nothing, and I long ago arrived at the conclusion, so well put by Agassiz, when he says, "we trust that the time is not distant when it will be universally understood that the battle of the evidences will have to be fought on the field of physical science, and not on that of metaphysical."* Many of the metaphysicians' objections have been controverted by that champion of natural selection, Mr. Darwin's true knight, Alfred Wallace, in his papers on "Protection"† and "Creation by Law,"‡ &c., in which the doctrines of "continual interference," the "Theory of Beauty," and kindred subjects, are discussed with admirable sagacity, knowledge, and skill. But of Mr. Wallace and his many contributions to philosophical biology it is not easy to speak without enthusiasm, for, putting aside their great merits, he, throughout his writings, with a modesty as rare as I believe it to be in him unconscious, forgets his own unquestioned claims to the honour of having originated, independently of Mr. Darwin, the theories which he so ably defends.

On the score of Geology, the objectors chiefly rely on the assumed perfection of the geological record; and since almost all who believe in its imperfection, and many of the other school, accept the theories both of evolution and natural selection, wholly or in part, there is no doubt but Mr. Darwin claims the great majority of geologists. Of these one is in himself a host—the veteran Sir Charles Lyell—who, after having devoted whole chapters of the first editions of his "Principles" to establishing the doctrine of special creations, abandons it in the tenth, and this, too, on the showing of a pupil; for, in the dedication of his earliest work, "The Naturalist's Voyage," to Sir C. Lyell, Mr. Darwin states that the chief part of whatever merit he or his works may pos-

* Agassiz on the Contemplation of God in the Kosmos. *Christian Examiner*, 4th series, vol. xv., p. 2.

† *Westminster Review*.

‡ *Journal of Science*, October, 1867.

ness has been derived from studying the "Principles of Geology." I know no brighter example of heroism of its kind than this, of an author thus abandoning late in life a theory which he had for forty years regarded as one of the foundation stones of a work that had given him the highest position attainable amongst contemporary scientific writers. Well may he be proud of a superstructure raised on the foundations of an insecure doctrine when he finds that he can underpin it, and substitute a new foundation, and, after all is finished, survey his edifice, not only more secure, but more harmonious in its proportions than it was before; for assuredly the biological chapters of the tenth edition of the "Principles" are more in harmony with the doctrine of slow changes in the history of our planet than were their counterparts in the former editions.

To the astronomers' objections to these theories I turn with diffidence; they are strenuously urged in what is in my opinion the cleverest critique of them that I have hitherto met with, and which appeared in the *North British Review*. It is anonymous—I am wholly ignorant of its author; and I regret to find, that, in common with the few other really able hostile critiques, it is disfigured by a dogmatism that contrasts unfavourably with Mr. Darwin's considerate treatment of his opponents' methods and conclusions. The author starts, if I read him aright, by professing his unfamiliarity with the truth and extent of the facts upon which the theories of evolution and natural selection are founded, and goes on to say, that "the superstructure based on them may be discussed apart from all doubts as to the fundamental facts." The liberty thus to discuss no one may dispute or curtail, but the biologist will ask, to what end can such discussion lead? Who would attach much weight to the verdict of a judge passed on evidence of which he knew neither the truth nor the extent? As well might a boy, guiltless of mathematics, set himself to test the 47th proposition of the 1st book of Euclid, by constructing paper squares corresponding to the sides of a right-angled triangle, then cutting up the smaller squares, try to fit the pieces into the larger, and failing to do this with exactitude, conclude of the problem, as the reviewer does of the theory, that it is "an ingenious and plausible speculation, marking at once the ignorance of the age and the ability of the philosopher."

The most formidable argument urged by the reviewer is, that "the age of the inhabited world as calculated by solar physics, is proved to have been limited to a period wholly inconsistent with Darwin's views." This would be a valid objection if these views depended on those of one school of geologists; and if the 500,000,000 years, which the reviewer adopts as the age of the world, were, as an approximate estimate, accepted by either astronomers or physicists. But in the first place the reviewer assumes that the rate of change in the condition of the earth's surface was vastly more rapid at the beginning than now, and has gradually slackened since; but overlooks the consequence, that according to all Mr. Darwin's principles, the operations of natural selection must in such cases have been formerly correspondingly more rapid; and in the second, are the speculations as to the solidity of the earth's crust, dating back only 500,000,000 years, to be depended upon? In his great work the author* quotes for these numbers, gives as possible limits 20,000,000, or 400,000,000 years; whilst other philosophers assign to the habitable globe an age far exceeding the longest of these periods. Surely, in estimates of such a nature as the above, which are calculated from data themselves in a great degree hypothetical, there are no principles upon which we are warranted in assuming the speculations of the astronomer to be more worthy of confidence than those of the biologist.

A former most distinguished president, and himself an astronomer, Professor Whewell, has said of Astronomy "that it is not one of the lessons of science, but the one of perfect science, the only branch of human knowledge in which we are able fully and clearly to interpret Nature's

oracles; so that by that which we have tried we receive a prophecy of that which is untried."* Now, whilst fully admitting, and proudly as every scientific man ought, that Astronomy is the most certain in her methods and results of all sciences, that she has called forth some of the highest efforts of the intellect, and that her results far transcend in grandeur those of any other science, I think we may hesitate before we therefore admit her queenship, her perfection, or her sole claims to interpretation and to prophecy. Her methods are those of the mathematicians; she may call geometry and algebra her handmaidens, but she is none the less their slave. No science is really perfect, certainly not that which lately erred 2,000,000 miles in so fundamental a datum as the earth's distance from the sun. Have Faraday and Von Baer interpreted no oracles of Nature fully and clearly? Have Cuvier and Dalton not prophesied and been true prophets?

Claims to queenship do not accord with the spirit of science;† neither would I liken the domain of natural knowledge to a hive, in which every comb is a science, and truth the one queen over them all.

It remains to say a few words on some prospects which this Norwich meeting opens.

A new science has dawned upon us; that of the early history of mankind. Pre-historic Archaeology (including as it does the origin of language and of art) has been the latest to rise of a series of luminaries that have dispelled the mists of ages and replaced time-honoured traditions by scientific truths. Astronomy, if not the queen, yet the earliest of sciences, first snatched the torch from the hands of dogmatic teachers, tore up the letter and cherished the spirit of the law. Geology next followed, but not till two centuries had elapsed, nor, indeed, till this our day in divesting religious teaching of many cobwebs of scientific error. It has told us that animal and vegetable life preceded the appearance of man on the globe, not by days but by myriads of years, and how late this knowledge came we may gather from the fact, that Lawrence in his previously quoted lectures,‡ delivered so late as 1818, says of the extinct races of animals, that "their living existence has been supposed, with considerable probability," to be of older date than the formation of the human race.

And, last of all, this new science proclaims man himself to have inhabited this earth for, perhaps, many thousands of years before the historic period,—a result little expected less than thirty years ago when the Rev. W. V. Harcourt, in his address to the Association at Birmingham,§ observed that "Geology points to the conclusion that the time during which man has existed on the globe, cannot materially differ from that assigned by Scripture," referring, I need not say, to the so-called Scripture chronology, which has no warrant in the Old Testament, and which gives 5874 years as the age of the inhabited globe.

Pre-historic Archaeology now offers to lead us where man has hitherto not ventured to tread. Can we, whilst truthfully and fearlessly pursuing this inquiry, separate its physical from its spiritual aspect? will be the uppermost thought in the minds of many here present: to separate them is, I believe, indeed impossible, but to search out common truths that underlie both is permitted to all. Mr. Disraeli,§ has well said of truth, that it is the sovereign passion of mankind. And it should be emphatically so in the minds engaged in this search, where religion and science should speak peace to one another, if they are to walk hand in hand in this our day and generation.

A great deal has of late been said and written about the respective attitudes of Religion and Science; and my predecessor, the Duke of Buccleuch, dwelt on this in his address

* Rev. W. Whewell. Reports, 1833, p. xiii.

† Lectures on Physiology, Zoology, &c., p. 52.

‡ Reports, p. 17.

§ Life of Lord George Bentinck.

* Thomson and Tait, Treatise on Natural Philosophy, vol. 1., p. 716.

last year with great good sense and good taste, and pointed out how much the progress of knowledge depended on this attitude being mutually considerate and friendly. During the first decades of my scientific life, science was rarely, within my experience, heard of from the pulpits of these islands: during the succeeding, when the influence of the *reliquæ diluvianæ* and the Bridgewater treatises was still felt, I often heard it named, and always welcomed. Now, and of late years, science is more frequently named than ever, but too often with dislike or fear rather than with trust and welcome.

The Rev. Dr. Hanna, in an eloquent and candid contribution to the *Contemporary Review*,* has adduced a long list of eminent clergymen of various denominations who have adorned science by their writings, and religion by their lives: I do not ignore their contributions, still less do I overlook the many brilliant examples of educated preachers who give to science the respect due to it. But Dr. Hanna omits to observe that the majority of these honoured contributors were not religious teachers in the ordinary sense of the term: nor does he tell us in what light many of their scientific writings were regarded by a large body of their brother clergymen, those resident in the country especially, from whom alone an overwhelming proportion of the population ever hear the name of science.

In return, let each pursue the search for truth, the archaeologist into the physical, the religious teacher into the spiritual history and condition of mankind. It will be in vain that each regards the other's pursuit from afar, and turning the object glass of his mind's telescope to his eye, is content when he sees how small the other looks.

To search out the whence and whither of his existence is an unquenchable instinct of the human mind; to satisfy it, man in every age, and in every country, has adopted creeds that embrace his past history and his future being: and has eagerly accepted scientific truths that support the creeds; and but for this unquenchable instinct, I for one believe, that neither religion nor science would have advanced so far as they have into the hearts of any people. Science has never in this search hindered the religious aspirations of good and earnest men; nor have pulpit cautions, which are too often the ill disguised deterrents, ever turned inquiring minds from the revelations of science.

A sea of time spreads its waters between that period to which the earliest traditions of our ancestors point, and that far earlier period when man first appeared upon the globe. For his track upon that sea man vainly questions his spiritual teachers. Along its hither shore, if not across it, science now offers to pilot him. Each fresh discovery concerning pre-historic man is as a pier built on some rock its tide has exposed, and from these piers arches will one day spring that will carry him further and further across its depths.

Science, it is true, may never sound the depths of that sea, may never buoy its shallows, or span its narrowest creeks, but she will still build on every tide-washed rock; nor will she deem her mission fulfilled till she has sounded its profoundest depths and reached its furthest shore, or proved the one to be unfathomable and the other unattainable, upon evidence not yet revealed to mankind. And if in her tracks he bears in mind that it is a common object of religion and of science to seek to understand the infancy of human existence—that the laws of mind are not yet relegated to the domain of the teachers of physical science, and that the laws of matter are not within the religious teacher's province, these may then work together in harmony and with good will.

But if they would thus work in harmony, both parties must beware how they fence with that most dangerous of all two-edged weapons, Natural Theology—a science falsely so-called, when, not content with trustfully accepting truths hostile to any presumptuous standard it may set up, it seeks to weigh the infinite in the balance of the finite, and shifts its ground to meet the requirements of every new fact that science es-

tablishes, and every old error that science exposes. Thus pursued, Natural Theology is to the scientific man a delusion, and to the religious man a snare, leading too often to disordered intellects and to atheism.

One of our deepest thinkers,* Mr. Herbert Spencer, has said:—"If religion and science are to be reconciled, the basis of the reconciliation must be the deepest, widest, and most certain of facts, that the power which the universe manifests to us is utterly inscrutable." The bonds that unite the physical and spiritual history of man, and the forces which manifest themselves in the alternate victories of mind and of matter over the actions of the individual, are, of all the subjects that physics and psychology have revealed to us, the most absorbing, and are, perhaps, utterly inscrutable. In the investigation of their phenomena is wrapped up that of the past and the future, the whence and the whither, of his existence; and, after a knowledge of these, the human soul still yearns, and thus passionately cries, in the words of a living poet,†

"To matter or to force
The all is not confined;
Beside the law of things
Is set the law of mind:
One speaks in rock and star,
And one within the brain,
In unison at times,
And then apart again;
And both in one have brought us hither,
That we may know our whence and whither.

The sequences of law
We learn through mind alone;
We see but outward forms,
The soul the one thing known;—
If she speak truth at all,
The voices must be true
That give these visible things,
These laws their honour due,
But tell of One who brought us hither,
And holds the keys of whence and whither.

He in his science plans,
What no known laws foretell;
The wandering fires and fixed
Alike are miracle:
The common death of all,
The life renewed above,
Are both within the scheme
Of that all-circling love.
The seeming chance that cast us hither,
Accomplishes his whence and whither."

REPORT OF THE KEW COMMITTEE OF THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE FOR 1867-68.

The committee of the Kew Observatory submit to the Council of the British Association the following statement of their proceedings during the past year:—

The meteorological office, to which allusion was made in the last report, continues in operation, Kew being the central observatory, as arranged with the meteorological committee appointed by the Council of the Royal Society. In consequence of this arrangement there has been during the past year a considerable access of work to the Kew Observatory, and the duties undertaken by that establishment may, as in the last report, for clearness' sake, be again considered under the two following heads:—

- (A) The work done by the Kew Observatory under the direction of the British Association.
- (B) That done at Kew as the Central Observatory of the Meteorological Committee.

This system of division will therefore be adopted in this report; but it ought to be mentioned that the financial statement appended to it refers only to the first of these divisions, since the work done at Kew for the meteorological committee

* First Principles, by Herbert Spencer, Ed. II., page 46.

† The Reign of Law, by F. T. Palgrave. *Macmillan's Magazine*, March, 1867.

has been paid from funds supplied by the committee, and not in any way from money subscribed by the British Association.

(A) WORK DONE BY KEW OBSERVATORY UNDER THE DIRECTION OF THE BRITISH ASSOCIATION.

1. *New Instruments for Colaba Observatory.*—The chairman of the Kew committee, shortly after the meeting at Dundee, received a communication from Mr. Chambers, the superintendent of the Colaba Observatory, Bombay, requesting the support of the Kew committee in his application to the India Board for a supply of self-recording magnetographs and other instruments required for his observatory. This was ultimately brought before the Council of the British Association; and in consequence of the steps taken, Sir Stafford Northcote, in a letter to General Sabine, dated 30th January, 1868, sanctioned the supply of new instruments for the observatory at Bombay, while General Sabine, on behalf of the Kew committee, undertook to select the following instruments required:—

- (1) A set of self-recording magnetometers for registering by photography changes of declination, horizontal force, and vertical force.
- (2) Thomson's electrometer, arranged for photographic self-registration.
- (3) A self-recording barograph and thermograph, of the pattern adopted by the meteorological committee (added afterwards).
- (4) Apparatus for measuring and tabulating the curves given by the above-named instruments.
- (5) Photographic apparatus, porcelain dishes, and boxes for paper and photograms.
- (6) Moffat's ozonimeter, in box with clockwork and rotating cylinder.
- (7) Beam-compasses, with steel points and tangent screw adjustment to measure 4 feet (for verification of distances in deflection experiments).
- (8) Rotating frame with large glass jar for testing thermometers.

2. *Magnetic work.*—The self-recording magnetographs, ordered by the India Board for Mr. Chambers, have verified at Kew, and returned to the India Office, from which they have been doubtless despatched ere this to Bombay.

A differential declinometer (received from General Sabine's office) has been verified at Kew for Dr. Lemström, who has gone out as physical observer with the Spitzbergen expedition.

A unifilar has been received at Kew for Mr. Meldrum, of the Mauritius Observatory, and its constants are in process of being determined.

Senhor Viegas, of Coimbra, and Lieutenant Ielagin, of the Imperial Russian Navy, have received magnetic instruction at Kew; and a dip circle has been prepared for the latter gentleman, who purposes making observations with it at the various European Observatories.

The usual monthly absolute determinations of the magnetic elements continue to be made by Mr. Whipple, magnetic assistant; and the self-recording magnetographs are in constant operation as heretofore, also under Mr. Whipple, who has displayed much care and ability in the discharge of his duties.

The photographic department connected with the self-recording instruments is under the charge of Mr. Page, assisted by Mr. Foster, both of whom discharge their duties very satisfactorily.

An arrangement connected with the instrumental clock for shutting off the light every two hours, and thereby increasing the accuracy of the time scale, originally devised by Mr. Beckley, in connection with the self-recording meteorological instruments, has been adapted to the Kew, and also to the Mauritius and Bombay self-recording magnetographs, and the time-scale of the Kew magnetographs has been made the same as those of the other instruments.

It was proposed in the last report that the task of tabula-

ting and reducing the magnetic curves produced at Kew subsequently to January, 1865, should be performed by the staff at Kew working under the direction of Mr. Stewart. In accordance with this resolution 787 curves, being those of the declination from February, 1865, to April, 1867, have been measured for every hour, and the process of reduction of these measurements is well advanced.

The magnetical observations made at Ascension by Lieutenant Rokeby, R.M., have been nearly reduced by Mr. Whipple, and it is proposed to communicate the results to the Royal Society.

A comparison of the Kew and Lisbon magnetic curves during the magnetic storm of February 20-25, 1866, made by Senhor Capello, of the Lisbon Observatory, has been communicated to the Royal Society, and will be found published in their proceedings for May 28, 1868.

Mr. Stewart has likewise received from Senhor Capello a short paper "On the reappearance of certain periods of declination disturbance during two, three, or several days," which he proposes to communicate to the Royal Society.

The Rev. W. Sidgreaves and Mr. Stewart have been engaged in making intercomparisons of simultaneous disturbances of the declination at Stonyhurst and Kew, for both of which stations the instruments have the same scale. It would appear from these that during slow disturbances there is an absolute identity between the indications of the two instruments, even to their most minute features. On the other hand, the more abrupt disturbances appear to be exaggerated at Stonyhurst as compared with Kew to an extent which appears (at first sight) to depend upon the abruptness. Messrs. Sidgreaves and Stewart are investigating this phenomenon, which has clearly a physical and not an instrumental origin, and purpose communicating their results in a joint paper to the Royal Society.

3. *Meteorological Work.*—The meteorological work of the Observatory continues in the charge of Mr. Baker, who executes his duties very satisfactorily.

Since the Dundee meeting seventy-eight barometers have been verified, and seventy-one are at present in hand; 1,139 thermometers have likewise been verified, and fourteen standard thermometers have been constructed for the thermographs of the meteorological committee. Thirty-two thermograph thermometers have likewise been tested, twenty-four of these being for the meteorological committee and eight for opticians.

The self-recording meteorological instruments now at work at Kew will be again mentioned in the second division of this report. These are in the charge of Mr. Baker, the photography being superintended by Mr. Page.

Mr. Robert Addams has kindly made a preliminary experiment with his apparatus for freezing carbonic acid, which is now at Kew, and has also left specific instructions regarding it, so that the operation can in future be performed without assistance. The point corresponding to the temperature of freezing mercury has been determined for two thermometers belonging to the meteorological committee.

The self-recording barographs, thermographs, and anemographs for the six outlying observatories of the meteorological committee have been verified at Kew. A self-recording barograph and thermograph have likewise been verified for Messrs. R. and J. Beck, opticians; and the verification of another set for Mr. Chambers, of the Colaba Observatory, has been very recently completed.

The experiments made on aneroids at Kew by the request and at the expense of the meteorological committee, have formed the subject of a communication recently made to the Royal Society by that body.

4. *Photoheliograph.*—The Kew heliograph, in charge of Mr. De la Rue, continues to be worked in a satisfactory manner. During the past year 224 negatives have been taken on 140 days. Ninety pictures of the Pagoda in Kew Gardens have likewise been taken, in the hope of being able by this means to determine accurately the angular diameter of the sun.

Since the last meeting of the Association, a series of solar researches, in continuation of the second series, has been published (the expense of printing having been defrayed by Mr. De la Rue), entitled "Researches on solar physics. Appendix to second series.—On the distribution in heliographic latitudes of the sun-spots observed by Carrington; by Messrs. De la Rue, Stewart, and Loewy."

Two papers have likewise been communicated to the Royal Society by these gentlemen. The first of these is entitled "Researches on solar physics. Heliographical positions and areas of sun-spots observed with the Kew photoheliograph during the years 1862 and 1863."

The second is entitled "Account of some recent observations on sun-spots, made at the Kew Observatory."

Sun-spots continue likewise to be numbered after the manner of Hofrath Schwabe; and a table, exhibiting the monthly groups observed at Dessau and at Kew for the year 1867 has been communicated to the Astronomical Society, and published in their monthly notices.

The measurements of the Kew pictures for the year 1864 are approaching completion; when complete they will be communicated to the Royal Society. It is intended to work up rapidly the back years, preparatory to a final discussion.

Mr. De la Rue has recently received a letter from M. Struve, in which it is stated that the arrival at Kew of M. Berg, of the Wilna Observatory, in order to practise with the photoheliograph, may be shortly expected.

5. *Apparatus for Verifying Sextants.*—Several determinations have been made of the angular distances between the collimators of this instrument; but the result appears to indicate a greater want of fixedness in these than is desirable. Should, however, the apparatus come to be extensively employed for the verification of sextants, this may be overcome by means of frequent determinations of these angular distances by a theodolite.

6. *Miscellaneous Work.*—The time and attention of the Observatory Staff has been so much absorbed during the last year with the regular work of the Observatory that little or no progress has been made in miscellaneous experiments.

The instrument devised by Mr. Broun for the purpose of estimating the magnetic dip by means of soft iron, remains at present at the Observatory, awaiting Mr. Broun's return to England.

The Superintendent has received grants from the Royal Society for special experiments; and when these are completed an account will be rendered to that Society.

(B) WORK DONE AT KEW AS THE CENTRAL OBSERVATORY OF THE METEOROLOGICAL COMMITTEE.

This work may be divided into four heads, the first of these being the arrangement of self-recording meteorological instruments, their verification at Kew, and erection at the various stations; the second being the arrangement of a system of tabulating from the automatic records of these instruments; the third being the arrangement of a system by means of which the continued accuracy of the instruments themselves, and of their tabulated records, may be secured; while the fourth is the work done at Kew as being itself one of the Observatories of the meteorological committee.

1. *Arrangement, Verification, and Erection of Self-recording Instruments.*—In the last report of this committee a short account was given of the principles of construction of the system of self-recording meteorological instruments arranged at Kew, comprising the thermograph, barograph, and anemograph. A more detailed account has since been given by the meteorological committee in their report to Parliament for the year 1867, and it is therefore unnecessary to enter here into the subject. It ought, however, to be mentioned that the principle adopted in these instruments is to check the accuracy of their automatic records by means of reference to standards; and with this view the Kew committee have constructed a standard wet and dry bulb thermometer for each thermograph, and have verified a standard barometer for each barograph. When the various self-recording instruments had been completed by the opticians, they were sent to Kew, where they were examined and verified. They were then despatched to their respective stations in charge of the observer, who had been previously instructed at Kew; and finally, Mr. Beckley, mechanical assistant at Kew, went to the various stations and superintended the erection of the instruments. By his aid this was accomplished in a very thorough and satisfactory manner.

2. *System of Tabulation.*—It is not proposed to discuss here the system of tabulation. This has already been done, to a certain extent, in the report of the meteorological committee presented to Parliament; and the whole subject will, it is hoped, be fully treated of on some future occasion. Suffice it to say, that the system of tabulation was arranged at Kew, and that the tabulating instruments were all verified there before being sent to their respective observatories.

3. *Verification of Records.*—It has already been mentioned that the competency of the observers at the various stations to undertake the charge of the self-recording instruments was secured by a course of instruction at Kew, where they became acquainted with the principles of construction of the various instruments, with the photographic process necessary to obtain curves, and with the system of tabulation. In addition to this, the instruments were erected at the various stations by Mr. Beckley, and each observer was thus well started. It is not, however, enough in a project of this nature to secure a good beginning; it is, moreover, indispensable to see that the standard of excellence is maintained.

For this purpose it is proposed by the meteorological committee that Mr. Stewart should personally visit all the observatories every year; in addition to which some one of the Kew assistants might occasionally visit some station with a specific object in view. Mr. Stewart has already visited Stonylhurst, Glasgow, and Aberdeen; and, in addition to the preliminary visit to the various stations made by Mr. Beckley, Mr. Whipple has visited Falmouth.

Besides this inspection, it is also necessary to check at Kew the accuracy of the tabulated results that arrive there from the various stations. A close and constant scrutiny of these results is therefore made at Kew; and when any error is detected, it is brought before the notice of the observer who made it. All this involves a very considerable amount of labour, more especially at the commencement of the undertaking, and until the various observatories are in thorough working order. For the purpose of securing accuracy and uniformity in the reduction of the records of these instruments, it has been proposed that a set of rules should be drawn up under the sanction of this committee.

4. *Work done at Kew as one of the Observatories of the Meteorological Committee.*—This consists in keeping the barograph, thermograph, and anemograph furnished by the meteorological committee in constant operation. The barograph is erected in the room which contains the magnetographs, and which has a very small daily range of temperature. The outer part of the thermograph is attached to the north side of the observatory, towards the west, while the anemograph has been erected above the centre of the dome, so as not to interfere with the photoheliograph.

For the first two of these instruments traces in duplicate are obtained, one set being sent to the meteorological office, and one retained at Kew; as regards the anemograph, the original records are sent, while a copy of these on tracing-paper is retained.

The tabulations from the curves of the Kew instruments, and the examination of the results forwarded to Kew from the outlying observatories, so far as this last is not personally done by Mr. Stewart, are performed in a very satisfactory manner by Messrs. Whipple, Baker, and Page.

Mr. Steventon, a nephew of Captain Toynbee, of the meteorological office, has been in attendance at the observa-

tory for instruction for about twelve months, and latterly has given much assistance in the meteorological department of the observatory, with the details of which he is now fully conversant.

J. P. GASSIOTT,
Chairman.

Kew Observatory, 7th August, 1868.

Section A.

ADDRESS TO THE MATHEMATICAL AND PHYSICAL SCIENCE SECTION.

AUGUST 19, 1868,

BY PROFESSOR TYNDALL, LL.D., F.R.S., &c., PRESIDENT.

The celebrated Fichte, in his lectures on the "Vocation of the Scholar," insisted on a culture for the scholar which should not be one-sided, but all-sided. His intellectual nature was to expand spherically, and not in a single direction. In one direction, however, Fichte required that the scholar should apply himself directly to nature, become a creator of knowledge, and thus repay, by original labours of his own, the immense debt he owed to the labours of others. It was these which enabled him to supplement the knowledge derived from his own researches, so as to render his culture rounded, and not one-sided.

Fichte's idea is to some extent illustrated by the constitution and the labours of the British Association. We have here a body of men engaged in the pursuit of natural knowledge, but variously engaged. While sympathising with each of its departments, and supplementing his culture by knowledge drawn from all of them, each student amongst us selects one subject for the exercise of his own original faculty—one line along which he may carry the light of his private intelligence a little way into the darkness by which all knowledge is surrounded. Thus, the geologist faces the rocks; the biologist fronts the conditions and phenomena of life; the astronomer stellar masses and motions; the mathematician the properties of space and number; the chemist pursues his atoms; while the physical investigator has his own large field in optical, thermal, electrical, acoustical, and other phenomena. The British Association, then, faces Nature on all sides, and pushes knowledge centrifugally outwards, while, through circumstance or natural bent, each of its working members takes up a certain line of research in which he aspires to be an original producer, being content in all other directions to accept instruction from his fellow-men. The sum of our labours constitutes what Fichte might call the sphere of natural knowledge. In the meetings of the Association it is found necessary to resolve this sphere into its component parts, which take concrete form under the respective letters of our sections.

This Section (A) is called the Mathematical and Physical Section. Mathematics and Physics have been long accustomed to coalesce, and hence this grouping. For while mathematics, as a product of the human mind, is self-sustaining and nobly self-rewarding,—while the pure mathematician may never trouble his mind with considerations regarding the phenomena of the material universe, still the form of reasoning which he employs, the power which the organization of that reasoning confers, the applicability of his abstract conceptions to actual phenomena, render his science one of the most potent instruments in the solution of natural problems. Indeed, without mathematics, expressed or implied, our knowledge of physical science would be friable in the extreme.

Side by side with the mathematical method we have the method of experiment. Here, from a starting-point furnished by his own researches or those of others, the investigator proceeds by combining intuition and verification. He ponders the knowledge he possesses and tries to push it further, he guesses and checks his guess, he conjectures

and confirms or explodes his conjecture. These guesses and conjectures are by no means leaps in the dark; for knowledge once gained casts a faint light beyond its own immediate boundaries. There is no discovery so limited as not to illuminate something beyond itself. The force of intellectual penetration into this penumbral region which surrounds actual knowledge is not dependent upon method, but is proportional to the genius of the investigator. There is, however, no genius so gifted as not to need control and verification. The profoundest minds know best that Nature's ways are not at all times their ways, and that the brightest flashes in the world of thought are incomplete until they have been proved to have their counterparts in the world of fact. The vocation of the true experimentalist is the incessant correction and realisation of his insight; his experiments finally constituting a body, of which his purified intuitions are, as it were, the soul.

Partly through mathematical, and partly through experimental research, physical science has of late years assumed a momentous position in the world. Both in a material and in an intellectual point of view it has produced, and it is destined to produce, immense changes—vast social ameliorations, and vast alterations in the popular conception of the origin, rule, and governance of things. Miracles are wrought by science in the physical world, while philosophy is forsaking its ancient metaphysical channels, and pursuing those opened or indicated by scientific research. This must become more and more the case as philosophic writers become more deeply imbued with the methods of science, better acquainted with the facts which scientific men have won, and with the great theories which they have elaborated.

If you look at the face of a watch, you see the hour and minute-hands, and possibly also a second-hand, moving over the graduated dial. Why do these hands move, and why are their relative motions such as they are observed to be? These questions cannot be answered without opening the watch, mastering its various parts, and ascertaining their relationship to each other. When this is done, we find that the observed motion of the hands follows of necessity from the inner mechanism of the watch when acted upon by the force invested in the spring.

This motion of the hands may be called a phenomenon of art, but the case is similar with the phenomena of Nature. These also have their inner mechanism, and their store of force to set that mechanism going. The ultimate problem of physical science is to reveal this mechanism, to discern this store, and to show that from the combined action of both, the phenomena of which they constitute the basis must of necessity flow.

I thought that an attempt to give you even a brief and sketchy illustration of the manner in which scientific thinkers regard this problem would not be uninteresting to you on the present occasion; more especially as it will give me occasion to say a word or two on the tendencies and limits of modern science, to point out the region which men of science claim as their own, and where it is mere waste of time to oppose their advance, and also to define, if possible, the bourne between this and that other region to which the questionings and yearnings of the scientific intellect are directed in vain.

But here your tolerance will be needed. It was the American Emerson, I think, who said that it is hardly possible to state any truth strongly without apparent injury to some other truth. Under the circumstances, the proper course appears to be to state both truths strongly, and allow each its fair share, in the formation of the resultant conviction. For truth is often of a dual character, taking the form of a magnet with two poles; and many of the differences which agitate the thinking part of mankind are to be traced to the exclusiveness with which different parties affirm one half of the duality in forgetfulness of the other half. But this waiting for the statement of the two sides of a question implies patience. It implies a resolve

tion to suppress indignation if the statement of the one half should clash with our convictions, and not to suffer ourselves to be unduly elated if the half-statement should chime in with our views. It implies a determination to wait calmly for the statement of the whole before we pronounce judgment either in the form of acquiescence or dissent.

This premised, let us enter upon our task. There have been writers who affirmed that the pyramids of Egypt were the productions of nature; and in his early youth Alexander von Humboldt wrote an essay with the express object of refuting this notion. We now regard the pyramids as the work of men's hands, aided probably by machinery of which no record remains. We picture to ourselves the swarming workers toiling at those vast erections, lifting the inert stones, and, guided by the volition, the skill, and possibly at times by the whip of the architect, placing the stones in their proper positions. The blocks in this case were moved by a power external to themselves, and the final form of the pyramid expressed the thought of its human builder.

Let us pass from this illustration of building power to another of a different kind. When a solution of common salt is slowly evaporated, the water which holds the salt in solution disappears, but the salt itself remains behind. At a certain stage of concentration, the salt can no longer retain the liquid form; its particles, or molecules, as they are called, begin to deposit themselves as minute solids, so minute, indeed, as to defy all microscopic power. As evaporation continues solidification goes on, and we finally obtain, through the clustering together of innumerable molecules, a finite mass of salt of a definite form. What is this form? It sometimes seems a mimicry of the architecture of Egypt. We have little pyramids built by the salt, terrace above terrace from base to apex, forming thus a series of steps resembling those up which the Egyptian traveller is dragged by his guides. The human mind is as little disposed to look at these pyramidal salt-crystals without further question as to look at the pyramids of Egypt without inquiring whence they came. How, then, are those salt-pyramids built up?

Guided by analogy, you may suppose that, swarming among the constituent molecules of the salt, there is an invisible population, guided and coerced by some invisible master, and placing the atomic blocks in their positions. This, however, is not the scientific idea, nor do I think your good sense will accept it as a likely one. The scientific idea is that the molecules act upon each other without the intervention of slave labour; that they attract each other and repel each other at certain definite points, and in certain definite directions; and that the pyramidal form is the result of this play of attraction and repulsion. While, then, the blocks of Egypt were laid down by a power external to themselves, these molecular blocks of salt are self-positing, being fixed in their places by the forces with which they act upon each other.

I take common salt as an illustration because it is so familiar to us all; but almost any other substance would answer my purpose equally well. In fact, throughout inorganic nature, we have this formative power, as Fichte would call it—this structural energy ready to come into play, and build the ultimate particles of matter into definite shapes. It is present everywhere. The ice of our winters and of our polar regions is its handiwork, and so equally are the quartz, felspar, and mica of our rocks. Our chalk-beds are for the most part composed of minute shells, which are also the product of structural energy; but behind the shell, as a whole, lies the result of another and more subtle formative act. These shells are built up of little crystals of calc-spar, and to form these the structural force had to deal with the intangible molecules of carbonate of lime. This tendency on the part of matter to organise itself, to grow into shape, to assume definite forms in obedience to the definite action of force, is, as I have said, all-pervading. It is in the ground on which you tread, in the water you drink, in the air you breathe. Incipient life, in fact, manifests itself throughout the whole of what we call inorganic nature.

The forms of minerals resulting from this play of forces are various, and exhibit different degrees of complexity. Men of science avail themselves of all possible means of exploring this molecular architecture. For this purpose they employ in turn as agents of exploration, light, heat, magnetism, electricity, and sound. Polarised light is especially useful and powerful here. A beam of such light, when sent in among the molecules of a crystal, is acted on by them, and from this action we infer with more or less of clearness the manner in which the molecules are arranged. The difference, for example, between the inner structure of a plate of rock-salt and a plate of crystallised sugar or sugar-candy is thus strikingly revealed. These differences may be made to display themselves in phenomena of colour of great splendour, the play of molecular force being so regulated as to remove certain of the coloured constituents of white light, and to leave others with increased intensity behind.

And now let us pass from what we are accustomed to regard as a dead mineral to a living grain of corn. When it is examined by polarised light, chromatic phenomena similar to those noticed in crystals are observed. And why? Because the architecture of the grain resembles in some degree the architecture of the crystal. In the corn the molecules are also set in definite positions, from which they act upon the light. But what has built together the molecules of the corn? I have already said, regarding crystalline architecture, that you may, if you please, consider the atoms and molecules to be placed in position by a power external to themselves. The same hypothesis is open to you now. But, if in the case of crystals you have rejected this notion of an external architect, I think you are bound to reject it now, and to conclude that the molecules of the corn are self-positing by the forces with which they act upon each other. It would be poor philosophy to invoke an external agent in the one case and to reject it in the other.

Instead of cutting our grain into thin slices and subjecting it to the action of polarised light, let us place it in the earth and subject it to a certain degree of warmth. In other words, let the molecules, both of the corn and of the surrounding earth, be kept in a state of agitation; for warmth, as most of you know, is, in the eye of science, tremulous molecular motion. Under these circumstances, the grain and the substances which surround it interact, and a molecular architecture is the result of this interaction. A bud is formed; this bud reaches the surface, where it is exposed to the sun's rays, which are also to be regarded as a kind of vibratory motion. And as the common motion of heat with which the grain and the substances surrounding it were first endowed, enabled the grain and these substances to coalesce, so the specific motion of the sun's rays now enables the green bud to feed upon the carbonic acid and the aqueous vapour of the air, appropriating those constituents of both for which the blade has an elective attraction, and permitting the other constituent to resume its place in the air. Thus forces are active at the root, forces are active in the blade, the matter of the earth and the matter of the atmosphere are drawn towards the plant, and the plant augments in size. We have in succession the bud, the stalk, the ear, the full corn in the ear. For the forces here at play act in a cycle, which is completed by the production of grains similar to that with which the process began.

Now there is nothing in this process which necessarily eludes the power of mind as we know it. An intellect the same kind as our own, would, if only sufficiently expanded, be able to follow the whole process from beginning to end. No entirely new intellectual faculty would be needed for this purpose. The duly expanded mind would see in the process and its consummation an instance of the play of molecular force. It would see every molecule placed in its position by the specific attractions and repulsions exerted between it and other molecules. Nay, given the grain and its environment, an intellect the same in kind as our own, but sufficiently expanded, might trace out *a priori* every step of the process, and by the application of mechanical prin-

ciples would be able to demonstrate that the cycle of actions must end, as it is seen to end, in the reproduction of forms like that with which the operation began. A similar necessity rules here to that which rules the planets in their circuits round the sun.

You will notice that I am stating my truth strongly, as at the beginning we agreed it should be stated. But I must go still further, and affirm that in the eye of science the animal body is just as much the product of molecular force as the stalk and ear of corn, or as the crystal of salt or sugar. Many of its parts are obviously mechanical. Take the human heart, for example, with its exquisite system of valves, or take the eye or the hand. Animal heat, moreover, is the same in kind as the heat of a fire, being produced by the same chemical process. Animal motion, too, is as directly derived from the food of the animal, as the motion of Trevethick's walking-engine from the fuel in its furnace. As regards matter, the animal body creates nothing; as regards force, it creates nothing. Which of you by taking thought can add one cubit to his stature? All that has been said regarding the plant may be re-stated with regard to the animal. Every particle that enters into the composition of the muscle, a nerve, or a bone, has been placed in its position by molecular force. And unless the existence of law in these matters be denied, and the element of caprice be introduced, we must conclude that, given the relation of any molecule of the body to its environment, its position in the body might be predicted. Our difficulty is not with the quality of the problem, but with its complexity; and this difficulty might be met by the simple expansion of the faculties which man now possesses. Given this expansion, and given the necessary molecular data, and the chick might be deduced as rigorously and as logically from the egg as the existence of Neptune was deduced from the disturbances of Uranus, or as conical refraction was deduced from the undulatory theory of light.

You see I am not mincing matters, but avowing nakedly what many scientific thinkers more or less distinctly believe. The formation of a crystal, a plant, or an animal, is in their eyes a purely mechanical problem, which differs from the problems of ordinary mechanics in the smallness of the masses and the complexity of the processes involved. Here you have one half of our dual truth; let us now glance at the other half. Associated with this wonderful mechanism of the animal body we have phenomena no less certain than those of physics, but between which and the mechanism we discern no necessary connection. A man, for example, can say I feel, I think, I love; but how does consciousness infuse itself into the problem? The human brain is said to be the organ of thought and feeling; when we are hurt the brain feels it, when we ponder it is the brain that thinks, when our passions or affections are excited it is through the instrumentality of the brain. Let us endeavour to be a little more precise here. I hardly imagine that any profound scientific thinker who has reflected upon the subject exists who would not admit the extreme probability of the hypothesis, that for every fact of consciousness, whether in the domain of sense, of thought, or of emotion, a certain definite molecular condition is set up in the brain; that this relation of physics to consciousness is invariable, so that, given the state of the brain, the corresponding thought or feeling might be inferred; or, given the thought or feeling, the corresponding state of the brain might be inferred. But how inferred? It is at bottom not a case of logical inference at all, but of empirical association. You may reply that many of the inferences of science are of this character; the inference, for example, that an electric current of a given direction will deflect a magnetic needle in a definite way; but the cases differ in this, that the passage from the current to the needle, if not demonstrable, is thinkable, and that we entertain no doubt as to the final mechanical solution of the problem; but the passage from the physics of the brain to the corresponding facts of consciousness is unthinkable. Granted that a definite thought and

a definite molecular action in the brain occur simultaneously, we do not possess the intellectual organ, nor, apparently, any rudiment of the organ, which would enable us to pass by a process of reasoning from the one phenomenon to the other. They appear together, but we do not know why. Were our minds and senses so expanded, strengthened, and illuminated as to enable us to see and feel the very molecules of the brain; were we capable of following all their motions, all their groupings, all their electric discharges, if such there be; and were we intimately acquainted with the corresponding states of thought and feeling, we should be as far as ever from the solution of the problem, "How are these physical processes connected with the facts of consciousness?" The chasm between the two classes of phenomena would still remain intellectually impassable. Let the consciousness of love, for example, be associated with a right-handed spiral motion of the molecules of the brain, and the consciousness of hate with a left-handed spiral motion. We should then know when we love that the motion is in one direction, and when we hate that the motion is in the other; but the "WHY?" would still remain unanswered.

In affirming that the growth of the body is mechanical, and that thought, as exercised by us, has its correlative in the physics of the brain, I think the position of the "Materialist" is stated as far as that position is a tenable one. I think the materialist will be able finally to maintain this position against all attacks; but I do not think, as the human mind is at present constituted, that he can pass beyond it. I do not think he is entitled to say that his molecular groupings and his molecular motions explain everything. In reality they explain nothing. The utmost he can affirm is the association of two classes of phenomena of whose real bond of union he is in absolute ignorance. The problem of the connection of the body and soul is as insoluble in its modern form as it was in the pre-scientific ages. Phosphorus is known to enter into the composition of the human brain, and a courageous writer has exclaimed, in his trenchant German, "Ohne phosphor kein gedanke." That may or may not be the case; but even if we knew it to be the case, the knowledge would not lighten our darkness. On both sides of the zone here assigned to the materialist he is equally helpless. If you ask him whence is this "matter" of which we have been discoursing, who or what divided it into molecules, who or what impressed upon them this necessity of running into organic forms, he has no answer. Science also is mute in reply to these questions. But if the materialist is confounded, and science rendered dumb, who else is entitled to answer? To whom has the secret been revealed? Let us lower our heads and acknowledge our ignorance, one and all. Perhaps the mystery may resolve itself into knowledge at some future day. The process of things upon this earth has been one of amelioration. It is a long way from the *Iguanodon* and his contemporaries to the president and members of the British Association. And whether we regard the improvement from the scientific or from the theological point of view as the result of progressive development, or as the result of successive exhibitions of creative energy, neither view entitles us to assume that man's present faculties end the series—that the process of amelioration stops at him. A time may therefore come when this ultra-scientific region by which we are now enfolded may offer itself to terrestrial, if not to human, investigation. Two-thirds of the rays emitted by the sun fail to arouse in the eye the sense of vision. The rays exist, but the visual organ requisite for their translation into light does not exist. And so from this region of darkness and mystery which surrounds us, rays may now be darting which require but the development of the proper intellectual organs to translate them into knowledge as far surpassing ours as ours does that of the wallowing reptiles which once held possession of this planet. Meanwhile the mystery is not without its uses. It certainly may be made a power in the human soul; but it is a power which has feeling, not knowledge, for its base. It may be,

and will be, and we hope is turned to account, both in steadying and strengthening the intellect, and in rescuing man from that littleness to which, in the struggle for existence or for precedence in the world, he is continually prone.

Section B.

ADDRESS TO THE CHEMICAL SECTION.

AUGUST 20, 1868.

BY PROFESSOR E. FRANKLAND, F.R.S., PRESIDENT.

AT these annual reunions of those interested in chemical science it is usual for the president of this section to take a rapid survey of the progress of chemistry during the past year, and in conformity with that custom, it now devolves upon me to bring under your notice some matters which may, perhaps, with advantage arrest our attention for a few moments before we proceed to the actual business of the section.

It may be safely asserted that at no previous meeting of the British Association has there been evinced such an amount of interest in experimental science, and especially in chemistry, as that which pervades the length and breadth of this country. The international display of manufactures last year in Paris produced upon British visitors an impression which, if not quite unanimous in its kind, was almost entirely so, as regards the resulting conviction, viz. that in the education of the youth of this country scientific instruction is neglected, or systematically excluded, to an extent which finds no approach to a parallel in any other great European nation. There are many, and I confess to being one of them, who consider that even now our trade and manufactures are suffering to a very marked extent from this grave defect in our national education. It is thought by some that ignorance on the part of managers and workmen of the scientific truths upon which most manufacturing processes depend has not yet begun palpably to tell upon our manufacturing prosperity; but whatever difference of opinion there may be as to our present industrial position amongst nations, all agree in this, that without the extensive introduction of thorough scientific training into the education of those destined for industrial pursuits, we can no longer continue to maintain that pre-eminence in manufactures which we have now so long enjoyed.

The great science schools of the continent have no parallels in this country. The discouraging way in which scientific studies are being introduced into our older universities, the lack of the necessary funds for the proper endowment of professorships and for the provision of suitable buildings and apparatus in our modern institutions, and the insignificance of the rewards offered to successful students in science, have naturally operated most injuriously upon the extension of chemical culture. Whilst in Heidelberg, Zürich, Bonn, Berlin, Leipzig, and Karlsruhe, magnificent edifices have been raised, replete with all the newest contrivances for facilitating the prosecution of chemical studies, we are here still compelled to give instruction and conduct research in small and inconvenient buildings utterly inadequate to the requirements of modern chemistry. The large sums spent by the governments of Germany and Switzerland upon these establishments sufficiently testify to their opinion of the national value of chemistry in education. The laboratory at Zürich cost £14,000, that of Bonn £18,450, the one now nearly completed in Leipzig will cost £12,120, whilst the estimates for the Berlin laboratory, with its seventy-four rooms, amount to no less than £47,715.

Such being the comparatively discouraging circumstances under which chemistry is prosecuted in this country, it is not surprising that neither the number of investigators, nor the amount of new facts added to our knowledge during a given time, will bear a favourable comparison with the chemical activity of other and more favoured nations. In 1866, 1273 papers were published by 805 chemists, being at the average

rate of 1.58 paper for each investigator. Of these, Germany contributed 445 authors and 777 papers, or 1.75 paper to each author; France 170 authors and 245 papers, or 1.44 paper to each author; the United Kingdom 97 authors and 127 papers, or 1.31 paper to each author; whilst other countries furnished 93 authors and 124 papers, or 1.33 paper to each author. Our case is even worse than it appears to be from these figures; for a considerable proportion of the papers contributed by the United Kingdom were the work of chemists born and educated in Germany, but resident in this country. I am not aware how far a like comparison as regards activity in research obtains in other sciences; but if the United Kingdom takes a similar position in them, it is nothing less than a national disgrace that a country which perhaps more than any other owes its greatness to the discoveries of science should do so little towards the extension of scientific research.

Fortunately, however, this national apathy has not been shared by individual chemists, and the year has not passed without several important additions to our knowledge. The Master of the Mint has continued his remarkable researches on the occlusion of gases by metals. The extraordinary property possessed by some of the metals, but especially by palladium, of absorbing large volumes of certain gases, is one of the most interesting of modern observations, and can scarcely fail to throw light upon that obscure class of phenomena occupying the border land between the recognised domains of chemical and cohesive attraction.

Many cosmical changes, such as the variation of animal and vegetable species, move too slowly for our study. On the other hand, the sequence of transformations in chemical phenomena has generally been deemed too rapid to permit of the observation of anything but the final result. Harcourt and Esson, however, have shown that this phase of chemical action can be studied with very interesting results; in the cases of the action of oxalic acid upon permanganic acid, and of hydriodic acid upon hydroxyl, they have arrived at the following important conclusions:—

1. The rate at which a chemical change proceeds is constant under constant conditions, and independent of the time that has elapsed since the change commenced.
2. When any substance is undergoing a chemical change, of which no condition varies excepting the diminution of the changing substance, the amount of change occurring at any moment is directly proportional to the quantity of the substance.
3. When two or more substances act one upon another the amount of action at any moment is directly proportional to the quantity of the substances.
4. When the rate of any chemical change is affected by the presence of a substance which itself takes no part in the change, the acceleration or retardation produced is directly proportional to the quantity of the substance.
5. The relation between the rate of a chemical change occurring in a solution and the temperature of the solution is such that, for every additional degree, the number expressing the rate is to be multiplied by a constant quantity.

In mineral chemistry an active member of this section has done excellent service by the careful re-investigation of the compounds of vanadium. Roscoe's researches have led to the discovery that vanadium does not, as was previously believed, belong to the sulphur group of elements, but to the nitrogen group. The vanadic chloride, of anomalous vapour-density, is now shown to be a normal oxychloride. The isolation of vanadium will be looked forward to with much interest, since the atomic weight of this element assigns to it a position intermediate between phosphorus and arsenic.

Chemists had long regarded with regret the labour expended by meteorologists on observations made with the intention of estimating ozone in the atmosphere, in the absence of any conclusive evidence of the existence of this substance in the air. It is therefore highly satisfactory that Andrews, to whom we were already so much indebted for our knowledge of the properties of ozone, has at length proved that the reaction

exhibited by ozone test-papers at a distance from towns is in reality due to ozone. Thus the numerous observations, extending over so many years, now attain a value which they did not before possess.

The synthetical and constitutional departments of organic chemistry have received important additions from the discoverer of the first aniline colour. In pursuing his interesting researches on the salicylic series, Perkin has succeeded in artificially producing coumarin—the odoriferous principle of the sweet-scented woodruff and tonquin bean—besides a number of homologues of this substance. To the same chemist we are also indebted for a theoretical paper of great importance, on the probable difference in the value of the four bonds of carbon—a subject which, in its bearings upon isomerism, has long claimed, though it has never received, the earnest attention of chemists.

Perkin and Duppa have submitted the glyoxylic acid, originally obtained by them from dibromacetic acid, to a searching constitutional investigation, which has led them to the conclusion that this acid is identical with the one obtained by Debus from the slow oxidation of alcohol; thus establishing the fact that two semi-molecules of hydroxyl can unite with one and the same atom of carbon—a kind of combination the possibility of which had been disputed, although an analogous compound of hydrosulphyl is well known.

Maxwell Simpson, another of the most active and successful workers in this branch of organic chemistry, has continued his researches on the constitution of succinic acid, and on the direct transformation of chloriodide of ethylene into glycol.

To general organic chemistry important contributions have been made by Stenhouse on chloranil, and by Griess on the action of cyanogen upon amido-acids.

Physiological chemistry has received a new impulse from the highly instructive experiments of Crum Brown and Frazer, on the connection between chemical constitution and physiological action. It had been shown by Bunsen that cacodylic acid, though readily soluble, and containing 54 per cent of arsenic, produced, when administered to animals, no appreciable poisonous effect, whilst Landolt found that the poisonous properties of antimony disappeared in the salts of tetramethylstibonium. Messrs. Crum Brown and Frazer have studied the change in physiological action produced by the addition of methylic iodide to the natural alkaloids, strychnine, brucine, thebaine, codeine, morphine, and nicotine, and they show conclusively that the physiological action of these poisons is both greatly diminished in degree and completely changed in character. Their experiments also lead them to the singularly remarkable and important conclusion, that when a nitrile base possesses a strychnine-like action, the salts of the corresponding ammonium bases have an action identical with that of the curare poison. It is well known that curare and strychnine are derived from plants belonging to the same *genus*; and it is, therefore, interesting to observe such a relationship.

Again, the experiments of Dr. Arthur Gamgee on the action of carbonic oxide upon blood afford a striking illustration of the successful application of the most delicate processes of chemical analysis to physiological research.

I cannot close this brief and very imperfect summary of British chemical investigation during the past year without congratulating the section on the completion of that most valuable addition to the literature of the science—Watts's "Dictionary of Chemistry." The extent, completeness, unity of design, and general accuracy of this great work, reflect the highest credit upon its talented editor, who has conferred a boon upon his colleagues for which they can never sufficiently thank him.

The statistics illustrative of comparative chemical activity in this country and elsewhere warn me not to attempt, in these necessarily brief remarks, any analysis of foreign research. I cannot, however, avoid alluding to one or two out of the many foreign achievements of the past year.

In mineral chemistry, the application of the doctrines of *atomicity* to the formulation of natural minerals, in the new

edition of Dana's great work, constitutes an epoch in mineralogy which can scarcely fail to produce in that science results as important as those which this doctrine has already achieved in chemistry proper.

In organic chemistry, Hofmann's discovery of a new series of cyanogen compounds imparts a new stimulus to research on isomerism, and will long remain one of the great landmarks in organic research.

In Kolbe's laboratory the yearly harvest of synthetical discoveries has not failed. The direct conversion of carbon anhydride into oxalic acid by Dr. Drechsel, and of ammonium carbonate into urea by Basaroff, are amongst the most brilliant achievements yet recorded in this branch of research.

The artificial production of neurine by Wurtz illustrates strikingly the precision with which the results of chemical action can now be predicted. The atomic theory of Dalton, developed as it has been by the doctrine of *atomicity*, is rapidly assuming for chemical phenomena the position which the theory of gravitation occupies in cosmical science.

After a long period of indecision and confusion, as regards the atomic weights of a majority of the elements, it is gratifying to find that, at the present moment, an almost complete unanimity prevails amongst chemical teachers. Out of upwards of 900 papers, worked in all parts of the United Kingdom, at a recent examination connected with the Science and Art Department, the old atomic weights were employed in less than twenty cases. It is much to be regretted that this unanimity does not extend to notation and nomenclature; as regards the latter, a much greater uniformity prevails in France and Germany than in this country, and it is greatly to be desired that efforts should be made to bring about a better understanding on this subject. To the student a uniformly recognised nomenclature is perhaps of more importance than a generally accepted notation. For the present, the realisation of the latter appears to be impossible; but by a little mutual concession on the part of teachers, and especially of authors, there would be good hope of soon accomplishing the former.

ON CHLORIDE OF METHYLENE PREPARED FROM CHLOROFORM BY MEANS OF NASCENT HYDROGEN,*

BY W. H. PERKIN, F.R.S.

FROM the history of monocarbon derivatives as it stands at present it would appear that there exist still several bodies isomeric with each other. Thus we have the description of two bromides of methyl, the one liquid and the other gaseous;† two chlorides of methylene, the one boiling at 30.5° C., the other at about 40° C.;‡ two sulphur methylic acids, the one forming a hydrated barium salt, crystallising in four-sided tables, the other forming a similar salt, but anhydrous and crystallising in very long thin prisms.¶ But, although these bodies have been described by men of great eminence, yet it is considered by some chemists that this isomerism is improbable, and that these substances, if re-examined by the more accurate methods of the present day, would be found to be identical.

There can be no doubt that this question is one of considerable importance, because, if isomerisms exist in the monocarbon series, in all probability it will be found also to exist in the derivatives of all other polyatomic elements.

These considerations have induced me to commence an examination of some of the monocarbon derivatives, hoping that an experimental comparison of their properties may in some degree help to the solution of this problem.

In this communication I shall only give a short account

* British Association, Norwich Meeting, Section B.

† Bunsen.

‡ Regnault.

§ Butlerow.

¶ Dumas and Pellagot.

experiments upon the chloride of methylene obtained chloroform by the action of nascent hydrogen. Dr. rdson has already mentioned that this product may be sed in this manner, but has only studied its properties ally and as an anæsthetic.

method I have employed for the preparation of this results from the examination of a reaction pointed out by my friend Mr. J. Williams. He observed that red zinc, when brought in contact with chloroform monia, or even tetrachloride of carbon, reacted with energy, the mixture entering into violent ebullition. So I have studied this reaction, the principal products are—chloride of methylene and marsh gas; but little, chloride of methyl being produced.

preparing the chloride of methylene by this process I generally used an alcoholic solution of chloroform, with ess of powdered zinc, and but little ammonia. The ment was performed in a flask connected with an in- Liebig's condenser. On mixing the reagents, the nature gradually rises, and the mixture soon enters bullition, marsh gas at the same time passing away; he reaction has ceased, the products are digested and distilled off. The addition of water to this distillate an oil, consisting of chloroform and chloride of methy- o separate; this, when dried and subjected to fractional tion, gives a body boiling at about 40 to 42. To re- any traces of alcohol that it may still be contaminated t is agitated with a small quantity of sulphuric acid, ted, and again distilled. The following combustions made of two different quantities, the first boiling at 42 i the second at 40.5° to 41° C.:—

I.
1956 of substance gave
1013 of CO₂ and
0446 of H₂O.

II.
2401 of substance gave
1221 of CO₂ and
0509 of H₂O.

numbers give percentages agreeing with the formula l₂, as the following comparisons will show:—

	Theory.		Experiment.	
			I.	II.
C	12	14.117	14.12	13.86
H ₂	2	2.352	2.53	2.35
Cl ₂	71	83.531	—	—
	85	100.000		

formula was controlled by two Gay Lussac vapour

Theory.	Experiment.	
	I.	II.
2.941	2.992	3.012

ride of methylene obtained in this manner possesses me boiling point (or nearly so) as that obtained by ow from the chloride prepared from the iodide of methy- om iodoform. By description, it would therefore ap- to differ from Regnault's chloride of methylene, or ated chloride of methyl, which is said to boil at 30.5°, moreover, it appears to be acted upon by alcoholic of potassium more readily than that body; but, he sserting this to be a fact, I hope to compare these sub- s, and am at present occupied in preparing a quantity gnault's product. Chloride of methylene is but little upon with sodium.

po to examine the reactions and products of decom- n of this body so soon as I have sufficient material to with; unfortunately, the above process does not yield it e quantities.

tetrachloride of carbon, when treated with powdered zinc

and ammonia, yields a body which is apparently ordinary chloroform, and also marsh gas. I have not, however, examined this reaction sufficiently to state what are the true products.

PAPERS BEFORE THE CHEMICAL SECTION.

The following is a complete list of the papers which were brought before Section B (Chemical Science):—

- W. H. Perkin, F.R.S.—*On the Chloride of Methylene formed by the Action of Nascent Hydrogen on Chloroform.*
Dr. T. L. Phipson—*On Sulphocyanide of Ammonium.*
Dr. J. H. Gladstone—*Refraction Equivalents and Chemical Theories.*
C. Tomlinson, F.R.S.—*On the Action of Nuclei in Inducing Crystallisation.*
F. A. Abel, F.R.S.—*On the Chemical Composition of the great Cannon of Mohammed II., recently presented by the Sultan Aziz Khan to the British Government.*
John Spiller, F.C.S.—*Analysis of the Ancient Roman Mortar of the Castrum of Burgh, Suffolk.*
Alfred R. Catton—*Report of Synthetical Researches on Organic Acids.*
A. Matthiessen—*Report on the Chemical Nature of Cast Iron.*
A. Matthiessen and W. J. Russell—*Note on the Vesicular Structure of Copper.*
E. Frankland—*On the Combustion of Gases under Pressure.*
W. Perkin—*On the Preparation of Anhydrous Salts of some Organic Compounds.*
—Meusel—*On Paraffin and its Products of Oxidation.*
Alfred R. Catton—*Note on Löwig's Researches on the Action of Sodium Amalgam on Oxalic Ether.*
C. W. Siemens—*On Puddling Iron.*
Otto Richter—*On a System of Chemical Philosophy.*
T. Wood—*On Chemistry as a Branch of Education.*
E. Meusel and C. H. Gill—*On Paraffin and its Products of Oxidation.*
E. Meusel—*On the Physical Properties of Two Coloured Compounds.*
A. R. Catton—*Note on Löwig's Researches on the Action of Sodium Amalgam on Oxalic Ether.*
Angus Smith—*On the Absorption of Gases by Charcoal.*
J. Dewar—*On Coal-Tar Bases.*
T. Fairley—*Report on the Polyatomic Cyanides.*
J. Dewar—*On Kekulé's Model to Illustrate Graphic Formulae.*
W. Dittmar—*On Vapour Tensions.*
Ludwig Mond—*On the Manufacture of Sulphur from Alkali Waste in Great Britain.*
R. Gerstl—*Different Spectra of one Chromium Salt.*
J. A. Wanklyn—*A Note on Sea Water.*
J. A. Wanklyn—*Researches on the Ethers.*
F. Guthrie—*On Amyl-ethyl-methyl Acetaminine.*
A. R. Catton—*On Mitscherlich's Law of Isomorphism and on the so-called cases of Dimorphism.*

PLACE OF MEETING FOR NEXT YEAR.

It has been decided to hold the next meeting at Exeter, under the presidency of Professor G. G. Stokes, Sec. R.S.

THE TREATMENT AND UTILIZATION OF SEWAGE.

A recommendation forwarded to Section B of the Association was read by the President, and was to the effect that impartial reports should be made and communicated to the Association on the treatment and utilization of sewage in connection with the drainage of towns, in order that such facts and information as may guide future operations may be recorded from time to time. It was therefore proposed that some member of the Committee out of the three following sections should be appointed a committee to draw up the report:—Section B—J. H. Gilbert, F.R.S., F.C.S.; Section F—W. D. Harding, C. E.; Section G—Richard B. Grantham, C.E., F.G.S., with power to add to their number; and that a

sum of £30 be granted for the payment of such expenses as are incurred in the course of the investigations. The committee should be requested to include in the details of each report—

1st. The special circumstances of each case, such as the extent of district, the population, and the number of houses with or without the benefit of drainage.

2nd. The character of the sewage and water supply adopted in the district, and the quantity of sewage at disposal.

3rd. The mode of disposing of the sewage, with description of the works and their cost.

4th. The result pecuniarily to the district and to those who are selling or applying the sewage to the land, or otherwise, in any form whatever.

FOREIGN SCIENCE.

PARIS, AUG. 5, 1868.

Vesuvius.—The Sewage Experiments at Clichy.

SEVERAL investigations have been made within the past six or eight months on Vesuvius. M. Deville communicated M. Palmieri's letters to him, under the title of "Facts concerning the History of the Eruption of Vesuvius," to the Academy. M. Franco likewise gives an account of an excursion to the crater of Vesuvius, on the 21st February, 1868; and, lastly, we have the researches of M. Silvestri, professor of chemistry in the University of Catania. In one of his letters, M. Palmieri remarks that on the east base of the cone, a crack of about 400 metres in length had opened. From two places in this crack an abundance of lava flowed, descending on to the territory of Bosco-Reale, superposing the lava of 1850. This current flowed with marvellous rapidity, without violence, without projectiles; it ceased to flow at the end of seven days, when it reappeared at the summit of the Vesuvian cone. The whole of the fissure, at the outpouring of the lava, presented a series of fumeroles, which, in the neighbourhood of the actual vents, evolved sulphurous acid, and farther off, the vapour of water alone, or with carbonic acid. When the activity of the eruption permitted, M. Palmieri, with his assistant M. Franco, made the ascension of the cone, and examined the emanations from various currents of lava issuing from the base of the cone of eruption; they found carbonic acid. In the fumeroles near the cone in eruption, and near the point where the lava issued, abundant sublimations of chloride of iron were noticed; no traces of chloride of iron were found on the fumeroles from which the lava issued at the base of the Vesuvian cone, where the products were the chlorides of copper and lead. Upon aspirating the gas from a fumerole situated near Crocella, and passing it into a solution of chloride of barium, an abundant precipitate of sulphate of baryta was caused. Sulphates were found in this fumerole and in others. In another letter, M. Palmieri disputes an observation made by M. Silvestri—namely, the acidity of the fumeroles with the lava still flowing, or which are in their first period of existence. He affirms that the vapours from lava in motion give neither acid nor alkaline reaction. M. Silvestri states that the lava from this eruption presents itself, as usual, in every variety of form—as compact lava, scoriae, and ash or sand; the scoriaceous form predominating. This lava is dark grey coloured, nearly black, sometimes reddish on the surface. Dark green tints are met with in the lava which has cooled rapidly, and is found in small blocks; the colour is that assumed by pyroxene, one of the principal constituents of lava. The reddish tint appears to be due to the further oxidation of the iron compounds in the lava. It is possessed of crystalline structure, owing to the presence of augite and leucite. The following are the densities of the different varieties of lava at 14° C.:—Sand, 2.786; scoriae, 2.467; black compact lava, 2.819; greenish compact lava, 2.67;

vitrified compact lava (after artificial fusion) 2.698. In placing these results obtained for the lava from the last eruption of Vesuvius with those obtained for the last eruption of Etna, which occurred in 1865, the only difference worthy of note observed is that while the compact lava from Vesuvius, after artificial fusion, has a density of 2.698; that from Etna, after the same treatment, had a density of only 1.972. The lava from Vesuvius is slowly and incompletely attacked by the strongest mineral acids, excepting hydrofluoric acid. M. Silvestri therefore made the analysis by fusion with pure lime, according to Deville's method. The compact lava gave the following results:—Silica, 38.888; lime, 17.698; alumina, 14.127; magnesia, 3.333; protoxide of iron, 12.696; manganese, .01; potash, 1.19; soda, 10.0; water, 2.065. The amount of soda is very remarkable. The concluding portion of M. Silvestri's memoir, concerning the sublimates and the analyses of them, has already been noticed in Foreign Science.

Interesting experiments regarding the employment of sewage have been made on the Clichy territory, a little distance from the mouth of the Seine. The chemical separation of the matters operated upon, and the direct distribution, without previous purification, have been the two processes experimented with. According to a report of the engineer, M. Mille, charged to conduct the necessary trials, the chemical operation results from a determinate proportion of sulphate of alumina, which precipitates the matters in suspension and causes the clarification of the water. The expenses of the operation assume very small proportions when account is taken of the yield—19 francs per ton for the precipitate, which constitutes an excellent manure, and 5 centimes per cubic metre for the clarified liquor. The total expense for this first process of purification is 2 centimes per cubic metre of sewage treated chemically. The other process, that is to say the direct distribution, has given, since 1867, very good results. Thus fertilised, the culture of the maize, or Indian corn, has furnished a yield of 11,000 kilos. to the hectare, and from beet-root plantations, 30,000 kilos. to the hectare have been obtained. At the Universal Exhibition of 1867, the monstrous bulbs from the experimental plantation at Clichy attracted considerable notice. The jurors charged with the examination of these products, testified that their size in no way detracted from their quality, and that their taste was not affected by the manure to which they owed their development. The quantity of sewage water supplied in the culture did not exceed the amount of irrigation practised by the grower on the soil previously charged with manure. The experiments commenced at Clichy are about to be carried out in the plain of Gennevilliers on a much larger scale, which will doubtless hasten the solution of this important problem.

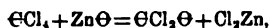
PARIS, AUG. 19, 1868.

Another process of Refining Sugar.—Oxychloride of Carbon.—Amides of Sulphoxyphosphoric Acid.

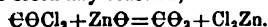
ANOTHER process of refining sugar has just been published. According to M. Monnier's experiments, when a current of anhydrous sulphurous acid is passed into a chamber containing coarse sugar, a bleaching action ensues, and three-fourths of the colouring matter of the sugar is destroyed, while no alteration whatever is suffered by the sugar itself. After this treatment, the sugar is strongly impregnated with sulphurous acid, but the presence of this body does not interfere with subsequent operations. About 4 parts of sulphur are required for every 1000 of sugar, but when the process is in regular operation, the amount of sulphur can be sensibly diminished. The sulphurous acid gas is obtained by burning sulphur in a small furnace adjoining the chamber. When the operation is terminated the sugar is dissolved in water, and the sulphurous acid neutralised by lime previously converted into sucrate of M. Monnier feared that, in practice, the anhydrous sulphur acid might modify the sugar, and convert a portion into

sugar. He has, however, convinced himself that no action of this kind takes place; the proportion of uncrystallisable sugar, found by analysis, after treatment by the process, being always exactly equal to the original amount. In all the experiments the sugar remained exposed to the bleaching action for forty-eight hours. This process gives excellent results with the strongly-coloured West Indian sugars; with samples less coloured the action is not so marked. In the first case, two-thirds or three-fourths of the colouring matter is completely removed.

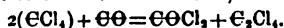
M. Schützenberger has produced oxychloride of carbon by substituting Cl_2 by Θ , in tetrachloride of carbon, ΘCl_4 . The formation of this substance was effected in three different ways. When chloride of carbon and dry oxide of zinc were heated together in a close vessel to 200° , for several hours, upon opening the tube, a large quantity of gas containing oxychloride of carbon escaped. A considerable quantity of carbonic acid is also formed by this treatment; the first reaction is—



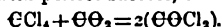
followed by the secondary reaction,—



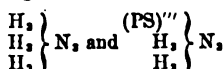
Another mode of formation is by passing over pumice stone, heated to 350° , a mixture of carbonic oxide and the vapour of tetrachloride of carbon. In this case,—



Thirdly, the carbonic oxide in this reaction may be replaced by carbonic acid with perfect success, the reaction being—

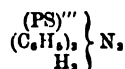


The following is an abstract of a note on the amides of sulphyphosphoric acid communicated to the Academy by M. Chevrier, in April. According to M. Baudrimont's experiments, published in 1861, chlorosulphide of phosphorus absorbs ammonia gas, at the same time becoming heated and solid; 6 grammes of PSCl_2 * take up 1.8 grammes of this gas, corresponding to three equivalents. The product formed is slightly yellow; heated, it evolves chloride and sulphide of ammonium, leaving an insoluble residue attacked by nitric acid with difficulty. Before calcination, the product was entirely soluble in water. M. Chevrier's experiments lead to a somewhat different result: 6 grammes of PSCl_2 absorb, not 1.8 grammes of ammonia gas, but 3.6 grammes, or six equivalents. Two different products are formed in this reaction—chloride of ammonium, and an amorphous solid body of a yellowish white colour. This body is insoluble in water, difficultly soluble in alcohol, ether, and sulphide of carbon. Heated in a test-tube it evolves sulphide of ammonium; heated with potash, it evolves ammonia. Fuming nitric acid attacks it with considerable energy, producing sulphuric acid and phosphoric acid. Analysis led to the formula PsN_2H_8 ; comparing this with the ammonia type, we have—



When chlorosulphide of phosphorus is added, in small portions, to liquid, ammonia in large excess, a lively reaction is produced. The temperature rises rapidly, and by agitating the mixture the chlorosulphide is soon entirely absorbed. Sulphyphosphoric acid of ammonia, corresponding to M. Wurtz's soda salt, and chloride of ammonium are thus obtained. This salt is as little stable as sulphyphosphoric acid itself. Its solution cannot be concentrated, neither by heat, nor in vacuo. The reaction of chlorosulphide of phosphorus upon aniline is also very energetic, one equivalent of the chlorosulphide and six of aniline take part in it. The temperature increases considerably, but no gas is disengaged. Neither the odour of chlorosulphide of phosphorus nor that of aniline is perceived in the product. By washing with water, the hydrochlorate of aniline is easily removed, and a yellow solid matter remains, containing sulphur, phosphorus, carbon, hy-

drogen, and nitrogen. Analysis leads to the formula, $\text{PSCl}_2\text{H}_8\text{N}_2$, or



This represents phenylsulphotriphosphamide. It is a hard yellow substance, brittle and friable. The amide is soluble in alcohol; it melts at 78° , and commences to decompose about 200° , disengaging aniline.

REPORTS OF SOCIETIES.

ACADEMY OF SCIENCES.

PARIS, JULY 6TH, 1868.

Rotatory Magnetic Power of Thallic Alcohol—Laws of Induction.—Thermorheometer.—Artificial Production of Pyroxene and Peridot.—Action of Iodine on Arseniuretted and Antimoniuretted Hydrogen.

THE following memoirs of chemical interest were communicated to the Academy at the meeting on July 6th. "On the cause of the great Rotatory Magnetic Power of Thallic Alcohol," by M. de la Rive; "On the Laws of Induction," by MM. Jamin and Roger; "On a Thermorheometer;" "On a Submarine Lamp supplied with Oxygen without Exterior Communication," by MM. Léauté and Denoyel; "Artificial Production of Pyroxene and Peridot," by M. Lechartier; "On a new Alkaloid isomeric with Toluidine contained in commercial Aniline," by M. Rosenstiehl (already translated in full); "New Researches concerning the action of Hypochlorous Gas on a mixture of Iodine and Acetic Anhydride," by M. Schützenberger; "Action of Iodine on Arseniuretted and Antimoniuretted Hydrogen," by M. Husson.

Pyroxene and peridot are produced under many circumstances. Etbelmen obtained them in submitting certain mixtures of silica, magnesia, and boric acid to the prolonged action of a high temperature, and a subsequent very slow cooling in a porcelain furnace. M. C. St. Clair Deville, while studying the action of alkaline chlorides and sulphates on the metamorphism of sedimentary rocks, showed that a silicate might be transformed into a crystalline substance, having the composition and the density of pyroxene. M. Lechartier has prepared all the varieties of pyroxene and peridot; the following artificially-prepared compounds were found to be identical with the natural crystals, by their crystalline form, their density, and composition. Wollastonite (CaO) SiO_2 , density 2.85; pyroxene, with lime and magnesia for bases (CaO , MgO) SiO_2 , $\text{D}=3.4$; pyroxene, with lime, magnesia, and protoxide of iron for bases (CaO , MgO , FeO) SiO_2 , $\text{D}=3.3$; pyroxene, with lime, magnesia, protoxides of iron and manganese (CaO , MgO , FeO , MnO) SiO_2 , $\text{D}=3.35$; peridot (MgO) 2SiO_2 , $\text{D}=3.19$; peridot, with magnesia and protoxide of iron (MgO , FeO) 2SiO_2 , $\text{D}=3.22$. The silica, intimately mixed with the oxides to which it is to be united, is placed in a crucible of gas retort carbon with anhydrous chloride of calcium broken in small pieces. The carbon crucible, furnished with a cover, is enclosed in an earthen crucible, and the space between the two filled with charcoal powder; the earthen crucible is then closed with its cover, which is carefully luted, and only a small opening left. The mixture is heated to bright redness for an hour or two. The temperature requires to be more intense and more prolonged for the production of peridot, than pyroxene; it is lower for ferruginous silicates than for the corresponding silicates which only contain lime and magnesia. The cooling is allowed to take place in the furnace. At the bottom of the crucible a button is found, containing the crystals of silicates disseminated in chloride of calcium; the latter compound being dissolved by water, the crystals are set at liberty. For pyroxene the following

* $\text{P}=31$, $\text{S}=32$, $\text{Cl}=35.5$.

proportions are used:—Silica, 10 grms.; lime, 4; magnesia, 3; chloride of calcium, 100; 3 or 4 grammes of transparent colourless crystals, from 6 to 10 millimetres in length, are obtained. In the preparation of pyroxene, the lime can be replaced by anhydrous fused bisulphate of soda, and the magnesia by sulphate of magnesia. Peridot is prepared by heating 4 grammes of silica with 8 of magnesia and 100 of chloride of calcium. Colourless transparent crystalline plates are obtained; they are soluble in acids, and although crystallised in the midst of chloride of calcium, they contain not a trace of lime.

Ammonia, in presence of iodine, gives iodide of nitrogen. Not less easily, M. Husson states, antimoniuiretted hydrogen and arseniuretted hydrogen from iodide of antimony and iodide of arsenic, when the two gases are made to pass over iodine. The ease with which the combination takes place may furnish a useful application in toxicological researches. A tube containing a small piece of iodine being joined to the Marsh's apparatus, gentle heat is applied to volatilise the iodine, which, upon condensation, lines the tube. Then, while the tube is still slightly warm, the gas is allowed to pass. If this contains arseniuretted hydrogen, the iodine will be bordered by a yellow line formed of little straw-like masses, having much analogy with iodoform: the iodine disappears completely. With antimoniuiretted hydrogen the reaction is less manifest; all the iodine collects, forming a deep ring, orange-tinted on the one side and brown on the other. But the action of heat enables these two iodides to be distinguished thus:—The yellow iodide of arsenic is transformed, one part into red iodide with disengagement of iodine, the other volatilises in the state of yellow vapours which are received on unsized paper; the same phenomenon is produced under the influence of an excess of arseniuretted hydrogen, whence M. Husson is inclined to conclude that a periodide of arsenic, AsI_3 , is first produced. Iodide of antimony, on the other hand, evolves red vapours, and leaves a little reduced antimony.

PARIS, JULY 20TH, 1868.

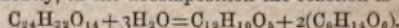
Magnetic Polarity of Artificially-prepared Iron Pyrites and Oxide.—Colouring Matter of Persian Berries.—Marshy Waters.

At the *séance* of the Academy, held on the 20th July, M. Sidot communicated his researches "On the Magnetic Polarity of Artificially-Prepared Iron Pyrites, and the Corresponding Oxide;" "The Colouring Matter of Persian Berries" was the subject of a communication by M. Schützenberger; and M. Dehérain contributed a note "On Marshy Waters."

On a former occasion, M. Sidot showed several samples of iron pyrites possessing magnetic polarity, obtained by passing a current of hydrosulphuric acid over the magnetic oxide. At that time he stated that the direction of the polar axis appeared to be in relation to the position of matters at the moment of their formation with reference to the magnetic axis of the globe. M. Sidot has now tested his supposition further by examining the behaviour of the oxide of iron, Fe_3O_4 , examining whether it suffered the same physical modifications, being placed in the same conditions, as magnetic pyrites, and whether the polarity was produced by the earth by removing all causes foreign to terrestrial action. When a tube of refractory clay is placed parallel to the magnetic needle, in a furnace free from iron, and in the tube a platinum boat filled with colcothar, which is heated to bright redness in a current of air for an hour, the result, after cooling, is a strongly agglomerated grey oxide, possessed of magnetic polarity. The extremity of the oxide turned towards the north is a south pole; it energetically repulses the pole of a magnetic needle pointing to the north of the earth. Magnetic oxide is likewise obtained by calcining colcothar in a platinum crucible. The upper extremity of the

mass presents a pole opposed to the south pole of the globe and the lower extremity an opposite pole. To obtain masses possessed of greater magnetic polarity a different disposition was made. A piece of iron plate, in the form of a tube, was suspended in a clay tube, placed vertically in a furnace traversed by a very rapid current of air, and heated to bright redness for the time necessary for the complete oxidation of the iron. Tubes of oxide were thus obtained possessed of magnetic polarity, and strongly repelling the poles of the magnetic needle. The polarity is always dependent upon the position of the iron plate. The magnet produced in this way was replaced in the furnace, reversed, and heated in the same conditions of temperature as before for one hour; after cooling, the poles were found to be reversed; that pole which is formed at the upper extremity is always similar to the north pole of the earth.

Persian berries contain colouring principles soluble in water, and capable of transformation, in certain circumstances, and notably by ebullition with sulphuric acid, into yellow pigments, sparingly soluble or insoluble (xanthorhamnine of Gellatly, rhamnegine of Lefort). Gellatly had stated this transformation to be a consequence of the decomposition of a glucoside; in a more recent work M. Lefort affirmed, on the contrary, that soluble rhamnegine, in becoming changed into rhamnine (rhamnetine of Gellatly), only suffered molecular modification, and that no sugar was formed. Also M. Bolley has considered rhamnetine as identical with quercetine from quercitron. M. Schützenberger finds, according to the indications of Gellatly, and contrary to the assertions of M. Lefort, that rhamnegine (rhamnine of Gellatly) gives a colourless saccharine matter upon ebullition with very dilute sulphuric acid. Operating with a solution of pure crystallised rhamnegine, 100 parts of colouring matter gave—sugar, 65, insoluble colouring matter, 42. The sugar from rhamnegine is uncrystallisable, of very decided sweetness; dried in the vacuum it presents an amorphous mass, which is deliquescent. It deviates the plane of polarisation to the right, about $+26^\circ$; its composition is represented by the formula $C_{12}H_{22}O_{11}$, thus an isomer of mannite. At 100° it chars, losing water and giving off an odour of caramel; the composition is then expressed by the formula $C_6H_{12}O_6$. The colouring matter insoluble in water, obtained in the decomposition, is distinguished by its composition and properties from quercetine; its composition may be expressed by the formula $C_{12}H_{18}O_8$. That of rhamnegine is $C_{12}H_{22}O_{11}$. Consequently, in the decomposition the reaction is



Rhamnegine, heated to 140° with acetic anhydride, gives a hexacetic derivative, $C_{12}H_{22}(C_2H_3O)_6O_{11}$, insoluble in water. In the same conditions, rhamnetine gives a diacetic derivative, $C_{12}H_{18}(C_2H_3O)_2O_8$. There exist in the berries two rhamnegines, α and β isomers, of which one, β , is more soluble in alcohol and more fusible than the other. This one gives, upon splitting up, a rhamnetine soluble and crystallisable in alcohol, while that furnished by the rhamnegine, α , is nearly insoluble in boiling alcohol. The acetic derivatives of the two rhamnegines are distinguished clearly the one from the other by their crystalline form and fusing point. To fix definitely the nomenclature of the products from Persian berries, M. Schützenberger proposes to use the terms rhamnegines, α and β , for the two soluble glucosides—rhamnine for the insoluble glucoside, and rhamnetines α and β for the products derived from the decomposition of the two rhamnegines.

NOTICES OF BOOKS.

Intercolonial Exhibition, 1866-67. Official Record. Melbourne, Australia.

THIS official record is chiefly a collection of the reports and awards of the jurors. The reports we may mention were furnished gratuitously, and they contain evidence of very

careful preparation. The interest taken by every one in regard to the exhibition is somewhat odd to us in England: railway companies, shipping companies, and carriers allowed packages and cases to pass free of expense, even analyses were made gratis, and indeed, reading these introductory portions, one begins to doubt whether in the old country we are not moving towards dignified eastern apathy.

A considerable part of the volume is devoted to a description of minerals found in the colony and exhibited. Probably the reports we first encounter are those relating to the exhibits most connected with chemistry. The first is "Mineral Products; Class 1, Section 1." Among the gold specimens exhibited was an ore containing gold, with sulphides of nickel and silver, in iron pyrites from South Australia. A specimen of black oxide of copper crystals from Western Australia is noteworthy on account of the form of the crystals, viz., rhombohedral, the hardness being 3. The crystals possess great lustre, and resemble iron glance in general appearance. The Murrumbidgee Mining Company exhibit a good collection of bismuth ores and metallic bismuth in ingots. Two specimens of earthy cobalt containing 8 per cent of cobalt, were exhibited, as well as an ingot, containing 64 per cent of copper and 28 per cent of cobalt, obtained by Thomas and Co's patent method of extracting cobalt from its ores. Coal was exhibited by the Mining Department of Victoria; an examination of the quality gave volatile hydrocarbons 31.74 per cent, fixed carbon 24.75 per cent, ash 43.51 per cent. Some very fine blocks of limestone, yielding upon analysis 95.5 per cent of carbonate of lime, were exhibited; there were likewise from Victoria, good sandstone, Fuller's earth and granite. Among the gems and precious stones collected in the colony, there were diamonds, sapphires, topazes, garnets, spinels, and tourmaline. From New South Wales very fine specimens of coal were exhibited: also kerosene shale and the oils obtained therefrom. Tasmanian coals were also exhibited and analysed; the amounts of ash in four varieties were respectively 8, 10, 16, and 20 per cent. Graphite, but not very pure, was exhibited from New Zealand.

In the introduction to Section 2, Class 1, devoted to chemical and metallurgical products and processes, the jurors remark: "In the vegetable kingdom, new species and even new varieties, will afford new resins, new essential oils, new alkaloids, new barks, and vegetable acids, and oft-times on the other hand they become new sources of well-known and useful vegetable products. The present Exhibition affords an example of this latter case, in which the grass-tree (*Xanthorrhoea Australis*) is made to yield alcohol, varnishes, and picric acid." After an exposition of the dependence of chemical manufactures, the jurors point out the great natural resources of the Australian colonies. At the outset there is no scarcity in fuel; then there is native sulphur in New Zealand, and iron and copper pyrites as a source of sulphur in Victoria and other places, ores of copper, lead, and bismuth, and probably cobalt also, are well provided in South and Western Australia, and of tin ore there is no lack either in quantity or quality. Iron ores are abundant everywhere; the magnetite of Tasmania contains 70 per cent of metal. We learn that chemical manufactures may be said to have already a fair existence, since the reporters remark that Melbourne vies with Sydney in the manufacture of oil of vitriol and other mineral acids, on a creditable scale. Samples of carbonate of soda and silicate of soda of Melbourne make were also exhibited.

The soap manufacture was represented by samples of great excellence. To quote from the report indeed this manufacture appears to have developed to a tolerably advanced state; "It includes, among other examples, the excellent saponified soap of Messrs. Gossage, Brothers, which may be mentioned as presenting the most modern phasis of the soap-maker's art, and which with colonial-made silicate and carbonate of soda exhibited by that firm, are of very high chemical interest, and deserving of unqualified commendation." In pharmaceutical chemistry there were not many exhibitors, but several of the exhibits, such as the granulations of the chaly-

beate salts, scale preparations of iron, quinine, and ammonia, are mentioned as deserving of notice. Likewise a collection of chemicals, and especially a fine crystal of nitrate of silver, prepared in the colony. One firm, in addition to the general exhibits, showed a series of products obtained from the grass-tree resin, viz., distilled spirits, picric acid, the resin, and a sample of polish made from the latter, as well as a specimen of wood stained with the acid. Photographic chemicals were exhibited by one or two firms; the collection was considered good.

These are, perhaps, the only two sections relating entirely to chemical operations, and we now turn to a few subjects, possibly interesting to our readers, distributed in different parts of the volume.

An ingenious filter was exhibited by Dr. de Bohn, to whom a medal was awarded for this exhibit. The filter consisted of two cylinders of copper, the one filled with porous stone, and the other with charcoal or other chemically-purifying material, the cylinders being connected by a short pipe and union. With a moderate pressure this apparatus filters very rapidly and effectually; it can be easily cleaned by reversing the cylinders end for end, and passing a good current of water through. The filter was constructed with a general view to clear wine in process of maturing from the minute organisms which give rise to acetous fermentation and other changes. The wine-growers we may perhaps notice, if only to draw attention to its dimensions, the quality of a really large number of samples from many growers being declared excellent.

We had intended to notice the paper-making materials; we will, however, merely remark that the manufacture of paper from the New Zealand flax (*Phormium tenax*), a fibre already known in Europe, is being now fairly started in the Australian colonies.

CORRESPONDENCE.

On Science Teaching in Schools.

To the Editor of the CHEMICAL NEWS.

SIR—The very excellent article in your last week's paper, by Mr. Rodwell, on the above subject (*Am. Repr. Sept., '68, pages 135-8*), exhibits, towards its close, a certain amount of hesitation, as though he were afraid of having committed himself to a too liberal programme, and asserts as an apology for the old régime—"But even if he learnt nothing of ordinary book-work, he learnt much that forms part of a liberal education—a gentlemanly tone and character;" a certain *esprit de corps*, &c.

I ask, are these recommendations inherent to the study of Latin and Greek? Do we find men, who, without ability to become great classical scholars, have passed through the Universities, and completed their curriculum, any less qualified to take their stand in the world as gentlemen, or wanting in the superficialities above referred to, than those who have obtained high classical honours?—Often the contrary.

To say the truth, the majority of those who are educated at college leave it with a very imperfect acquaintance with those languages which they have spent years in professing to acquire; and again, if we compare the sum of knowledge which the works of antiquity convey with that conveyed by modern, the disproportion is great in the extreme.

The consequences of the system which has hitherto prevailed are undoubtedly that a young man, in by far the majority of instances, has to set about gaining knowledge of a totally different kind, and to practically forget his previous learning when he has to commence his professional life.

But the children of the middle classes do not learn these dead languages: they do not, in nine cases out of ten, acquire them so as to appreciate the merits and beauties of ancient literature. Ask any of them if they could hold half an hour's conversation with Cicero, if now living; or, can

they read and enjoy his writings as they do those of Addison? Yet, unless a man does learn a language so as to be able to converse in it and understand it, or at least to read it with perfect facility, how is it to be a means of elevating the taste? Playfair, in his enquiries as to the causes of decline of nations, concludes that in ordinary boarding schools, "not above one in a hundred learns to read even Latin decently well—that is one good reader for every ten thousand pounds expended"; and thus day after day and year after year is spent upon "*Hic, hæc, hoc*," "*Propria quæ maribus*," "*As in presenti*," "*et (and), cum (when)*," and the like, to make a man of cultivated taste.

As a further incentive to the study of the dead languages, we are asked to admire the "veneration of all that is ancient, and intense admiration for the patriotism and valor which in former ages ennobled dynasties and raised mere specks upon the earth's surface into powerful states governing half the world;" in our schools we imbibe these influences, and carry them to the grave. That the patriotism and valor of the old Greeks and Romans is well worth studying, I do not deny, but that it is desirable for all boys, as the rule now is, to learn to read of it in the Greek or Latin language I do deny—French, German, or even English translations would convey the spirit of it equally well.

Further on, Mr. Rodwell states that he sees "nothing elevating or improving to the intellect in the knowledge of the modes of utilising tar liquor or of dyeing calico." In this I beg entirely to differ, and think the majority of the readers of the CHEMICAL NEWS will do the same. Is there nothing to elevate a man in the study of the beautiful laws of chemistry, which must be understood before the nature of the constituents of even coal-tar can be learnt?

But if chemical knowledge is to be treated in such a matter-of-fact way, let us for a moment consider how the learning of "The Learned" will bear it. Of what avail is it to elevate or improve the intellect, to read of the loves of the heathen gods in a language which expresses the sentiment "I love," by the word *amo*, and which has been entirely disused for many centuries? The fact is, human knowledge is so much more extensive than the opportunity of individuals for acquiring it, that it is of immense importance, so to economise the opportunity, as to gain as large and valuable a portion as we can. "Let the dead" languages "bury their dead." The English language possesses a sufficient store of literature without wasting time over others simply to increase it.—I am, &c.,

A. L. STEAVENSON.

Death by Carbolic Acid.

To the Editor of the CHEMICAL NEWS.

SIR—My note on the 10th ult. (*Am. Repr. Sept. '68*, page 166) having given pain to the friends of the late Mr. Berger, in consequence of my saying, without qualification, that he must have drunk carbolic acid, please allow of this trespass in explanation.

Dr. Metcalfe, who made the *post-mortem*, says in the *Lancet* of the 18th ult.,—"The death arose from asphyxia, or, speaking more correctly, from apnæa, doubtless from some of the acid getting into the larynx, simultaneously with the stomach." The jury returned a verdict of "accidental death, arising from inhaling carbolic acid, as a cure for the tooth-ache."

The object of my note was to correct this important error, and to show that the unfortunate gentleman must, accidentally, have *swallowed* the fluid—that death thus resulted, and not from its inhalation, as the verdict records.

The letter of Dr. Metcalfe now confirms this. Mr. Berger obviously intended to *inhale* the vapour only, through the long tube—this would, most probably, have given him the relief sought, as it has done others; but if, while in his agony, he unduly exerted himself to inhale a full dose (which is very likely), and if by accident the "large jar" of

fluid was upset (not at all unlikely with such a length of tubing attached), he might easily have taken in more than a sufficiency of the fluid to cause asphyxia and death.

No one, I think, can infer from the facts now published that the unfortunate gentleman (excellent as he was talented) intended suicide: for had this been his intention, he would neither have used such a clumsy apparatus, nor would he have selected carbolic acid.—I am, &c.,

T. A. READWIN.

108, Dorset Street, Aug. 5, 1868.

An Experiment in Diamagnetism.

To the Editor of the CHEMICAL NEWS.

SIR—A new experiment in diamagnetism, which suggested itself to me some time ago, and was realised with complete success, will perhaps be interesting to your readers. The object of the experiment is to show to a large number the diamagnetic action in such a way that it is manifest to all at once. For this purpose a disc of copper is made to revolve between the poles of the magnet by a pulley and band from a steady source of motion—for instance, an electro-motive engine. The diamagnetic effect may be made manifest in three ways.

1st. The band is let to run somewhat loosely. As long as the current is not turned into the magnet coils, the disc moves with great velocity. The turning-in of the current instantly stops the disc, forcing the band to slip. Thus motion and stoppage of the disc can be exhibited alternating, until the effect is fully appreciated.

2nd. The band is drawn tight. The turning-in of the current does not now stop the disc, but the great diminution of velocity in the prime mover shows the effort of the magnet to stop the disc. Here, too, alternation may be used as before.

3rd. The axis of the disc carries a small wheel with many teeth; a card held against the teeth of the revolving wheel gives a fine clear high note (Savart's wheel). As long as the magnet is not in action the prime mover keeps up a fixed velocity, and consequently the wheel gives the same note. On turning-in the current, if the hand slips the sound stops; if it does not slip the note is changed, from the decreased velocity of the prime mover. The alternations of sound and silence (or change of note) are very striking.

The single fluid Callan battery, of which I wrote to you some time ago, has now proved itself to be a capital working battery for any one engaged in study. It may be so arranged as to be always ready to give a powerful current of electricity, e.g., such as diamagnetism requires. A student who must look after his own battery will not go to the dreadful work of a ten or twenty-cell Grove for the experiments of a few minutes.—I am, &c.,

E. KERNAN.

Clongowes College,
August 13, 1868.

Question in Pneumatics.

To the Editor of the CHEMICAL NEWS.

SIR—Supposing the water of the sea at the depth of 28,050 feet to have a uniform density equal to that of pure water, the submerged air subjected to a pressure of 850 atmospheres would have the same density as the water, and would, consequently, not rise to the surface. But, taking into consideration the compressibility of water—about 1-20,000th of its volume for each atmosphere—the point at which air would have a density equal to that of water at the surface, is 28,000 feet. At this depth, however, water would possess a higher density than at the surface, for contraction of one volume due to a pressure of 850 atmospheres = $1-20,000 \times 850 = .0425$. Consequently, the density of water at a depth of 28,000 feet, as compared with that at the surface = $1 + (1 - .0425) = 1.9575 = 1.9575$. Hence, the bubble of air would possess buoyancy, and rise to the surface.—I am, &c.,

J. NOBLE.

MISCELLANEOUS.

Preparation of Thallium from the Liquors of the White Vitriol Works and Lead Mines at the Lower Harz.—At the Herzog-Julius Works, near Ramelsberg, Brunswick, occurs a mineral rich in zinc and lead ore (sulphides of the metals); after having been once roasted, this ore is lixiviated with water, yielding a solution of white vitriol, sulphate of zinc, of 1.441 specific gravity at 24° C. This liquor, of which thousands of hundredweights are to be had, is so rich in thallium, that, according to Bunsen, this metal may be obtained from the liquor by the pound weights. The following represents the composition in 100 parts of this fluid:—

Sulphate of zinc.....	21.740
" protoxide of manganese.....	8.230
" magnesia.....	0.717
" potash.....	0.581
" cadmium.....	0.536
" soda.....	0.443
" protoxide of iron.....	0.386
" copper.....	0.285
" lime.....	0.075
" alumina.....	0.060
" lead.....	0.008
" lithia.....	trace
Arsenious acid.....	trace
Oxide of antimony.....	trace
Phosphoric acid.....	trace
Chloride of thallium.....	0.050
Hydrated sulphuric acid.....	0.119
Hydrochloric acid.....	0.009
Water.....	66.761

100.000

According to Bunsen, thallium is best obtained from this liquor by precipitating, by means of metallic zinc immersed in the liquor, the metals copper, cadmium, and thallium, jointly. The metallic spongy mixture thus obtained is rapidly washed—first with water, by being placed in a bag made of woollen fabric; next, some sulphuric acid is added to the wash-water, whereby the metals thallium and cadmium get dissolved with evolution of hydrogen, while copper is left untouched; from the acid solution so obtained thallium is precipitated, by means of iodide of potassium, as a pure yellow iodide, which is further purified by washing and by decantation; from the remaining liquor cadmium is precipitated in the metallic state by zinc. One cubic metre of the above liquid yields in a few days 6.4 kilos. of spongy metallic precipitate, containing 4.2 kilos. cadmium, 1.6 kilos. copper, and 0.6 kilo. thallium, 7.4 kilos. of metallic zinc becoming dissolved. The solution of cadmium and thallium in sulphuric acid yields, on addition of 0.5 kilo. iodide of potassium, 0.07 kilos. of iodide of thallium. Thallium may be precipitated from the sulphuric acid solution by means of chlorides, but in so doing a not inconsiderable quantity of the metal is retained by the cadmium. The thallium may be directly obtained from the first liquid at once by precipitation with iodide of potassium, provided previously a sufficient quantity of hyposulphite of soda be added to keep the copper in solution; the application, however, of this latter method interferes with the object for which the liquor is prepared, viz., the making of sulphate of zinc.—*Polyt. Centralbl.*, 1898, No. 10.

Dr. Gustav Tschermak has read before the Imperial Geological Institute a very complete account of the gold mines of Transylvania. It appears that the precious metal is found disseminated in almost imperceptible particles in the trachytic rocks in the environs of Falathna and D'Abud Banya, where it is still worked by the most primitive methods. There are 300 families or partnerships, consisting each of three individuals, or thereabouts. A thousand quintals of the rock yield about 8,500 grains of pale yellow

gold, which contain a little silver. The rolled *débris* of the crystalline rocks found in the valley of l'Aranyos is carefully washed, and yields about half an ounce of gold to 31,000 quintals of stuff. This gold is of a deeper colour and contains less silver. They also find gold in a peculiar, freestone (*Carpithiques bocardes*), which is of a pale colour like that found in the trachytes. The gold mines of Transylvania have been worked from the earliest historic times, yet they still furnish above 2,000 lbs. *avoirdupois* annually.—*English Mechanic*.

Newcastle Chemical Society.—On Monday evening last, a meeting of the members of the Chemical Society, newly formed in connection with the Newcastle Literary and Philosophical Society, was held in the committee room at the Institute, Mr. R. C. Clapham in the chair. The Chairman observed that two or three years ago it appeared to him that in a district like this, possessing so many large manufacturing concerns, and also extensive collieries, in each of which chemistry held an important position, it would be very desirable to have some centre or focus round which to meet, in order to occasionally discuss the various new projects and schemes that appear from time to time. Many inventions were passed aside in the hurry and bustle of ordinary business life, and when they met occasionally and discussed in a friendly manner the various inventions with which the world at the present time teemed, perhaps they might be of use to the district, and able to add, a mite it might be, but still something to the prosperity and success of the district. The Chairman then desired the Secretary (Mr. Marreco) to read the report of the provisional committee. The report stated that the rules agreed to at the preliminary meeting had been revised by the provisional committee, and with some unimportant alterations, now presented the same to the general meeting for final approval. The provisional committee had also solicited the use of the Neville Hall lecture theatre, should the Society at any time require a larger accommodation than the committee room of the Literary and Philosophical Society afforded. The report further stated that the number of gentlemen, besides the gentlemen whom it was proposed to place upon the committee, who had signified their intention of joining the Society, was twenty-five. The rules were then discussed *seriatim*, and with some further amendments, were adopted. The following committee, nominated by the provisional committee, were elected:—President, Mr. I. L. Bell; Treasurer, Mr. John Pattinson; Secretaries, Dr. Geo. Lunge and Mr. A. F. Marreco; Committee Messrs. H. Bowman (Washington), H. B. Brady, R. C. Clapham, G. France, B. S. Procter, J. W. Swan, W. H. Richardson, and E. I. J. Browell. For the securing of members, the meeting resolved that the Secretary send copies of the rules, the minutes of that meeting, and stamped envelopes with the following printed form:—"I request you to propose my name as a member of the Newcastle Chemical Society," to persons likely to become members of the Society. The number of members enrolled up to Monday evening was 39. The first meeting of the Society will take place in October.

Increase in the Quantity of Carbonic Acid met with in Air, narrow Streets, and Lanes.—Professor Dr. Gunning records a series of experiments concerning the quantity of carbonic acid gas contained in the atmosphere of the City of Amsterdam. While the average of carbonic acid gas found in a most densely populous part of that city was only 4.13 vol. in 10,000 vols. of air, it appeared that the air in the thoroughfare called *Halsteeg*, and taken at 3 metres height above the pavement, contained from 4.9 to 5.4 vol. of carbonic acid gas in 10,000 vol. of air. The width of the thoroughfare alluded to is about the same as that of Birchin Lane, Lombard Street, E. C. Dr. Gunning advocates the proposed widening of the above-named thoroughfare as necessary, also, on sanitary grounds.

Something like a Lecture!—In a recent number, we published a paper, by Professor Henry Morton, Ph.D., describing some highly interesting experiments which had

been found to obviate the difficulties attending the production of monochromatic light in large quantities. Dr. Morton has since carried out his method on a grand scale, and with perfect success, at the Academy of Music, Philadelphia, before an audience of about 3,500 persons. Our space will not allow us to give a long report of the lecture; we must, therefore, content ourselves with merely referring to some of the experiments which were most novel and effective. The amount of apparatus employed was something extraordinary. There were ninety Bunsen's burners, five lime-lights, a galvanic battery of great power, an oxyhydrogen blow-pipe and two large cameras, induction coil and electric-wheel, screens and mirror, eight gas-bags, two hydrogen generators, and a large iron reservoir, holding 72 gallons of oxygen. It required fifteen assistants to work the apparatus, and forty young gentlemen from the University to represent the spectrum. To show that the temperature of the sun resembled that of the oxyhydrogen blow-pipe, the lecturer placed himself and apparatus on a platform secured to one of the stage traps, and then was raised to a great height above the floor, at which elevation he burned in the compound blow-pipe a piece of thick steel-wire rope. The fountain of scintillating sparks and drops of melted steel, descending in a broad sheet some 15 feet in height, poured upon the stage, and rolled in a torrent of fiery hail towards the footlights; proving to the audience that the metal was reduced to the gaseous condition in which it exists in the sun. A wheel, 5 feet in diameter, composed of Geissler tubes, was rotated, while flashes of electric light, produced by the large induction coil constructed for the University of Pennsylvania, produced the effect of a star darting innumerable coloured and constantly-changing rays. The stage was then illuminated with a number of lime-lights; a procession was formed of brilliantly-costumed figures, personating the prismatic colours, and bearing banners; at a signal, the lime-light was replaced by yellow light, produced by ninety Bunsen's burners, when every trace of colour disappeared, and the entire phalanx became a ghastly company of spectres bearing banners of white and black. This experiment brought this highly-interesting and instructive lecture to a close.

Legislation and Adulteration.—One of the measures still before Parliament is a bill which proposes to render penal the adulteration of articles of food, drink, or medicine. Every person who shall adulterate or order adulteration to be practised is to be fined on being convicted, and imprisoned for a second offence. The vendor who knowingly sells an article with which anything injurious to health has been mixed, or who sells as pure an adulterated article, is to be fined on conviction, and for a second offence exposed by advertisement. Vestries and district boards are to appoint salaried analysts and inspectors; purchasers of any article may demand an analysis on payment of a fee of one to five shillings; and convicted persons have the right of appeal to quarter sessions or a superior court. The object is laudable, but the measure would probably prove inoperative. How can the adulterator be caught at his work? Who can prove that the vendor of an impure article is cognisant of the adulteration? Why limit punishment to those who adulterate with materials injurious to health? Why not imprison the man who steals money from our pockets, and keeps health from our children by selling water at the price of milk, or starch for arrowroot? Why permit a dishonest tradesman to sell any quantity of adulterated goods so long as he does not say they are pure? Then the appointment of analysts is to be left to vestries and boards composed for the most part of men engaged in business—men, therefore, whose interest lies in the opposite direction. And what purchaser will care to prosecute, when, having already contributed by rate to the salaries of special officers, he must pay a special fee, attend at petty sessions, and probably again at quarter sessions, or a superior court? If this bill became law it is to be feared that the sole effect would be that dishonest people would thereby be instructed in the art of adulterating goods according to Act of Parliament, and the public be prevented from prosecuting by the expense and

trouble attending the process. We cannot doubt that a far better measure might be framed if competent men were consulted.—*Express*.

[The bill has, we believe, been abandoned.—*Ed. C. N.*]

Testimonial to Mr. Thomas Hall.—Within the last few days a complimentary certificate, handsomely engrossed on parchment, has been presented to Mr. Thomas Hall, in recognition of his services in the cause of scientific education. The signatures appended to the document are chiefly those of Mr. Hall's past pupils who have identified themselves with the medical and chemical professions. The text is as follows:—

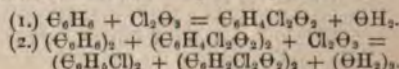
"LONDON, May 1st, 1868.

"We, the undersigned past pupils of Mr. Thomas Hall, B.A., F.C.S., have much pleasure in recording our high sense of the practical value of the system of scientific instruction inaugurated twenty-one years ago at the City of London School. Conscious of the direct benefits we have ourselves derived from attending Mr. Hall's lectures on chemistry and other branches of experimental science—many of us having, indeed, adopted a scientific profession in consequence of such early training—we gladly avail ourselves of the privilege of offering testimony to the success which has attended the efforts of our first teacher, and of certifying to the high qualifications which that gentleman has brought to bear upon the diffusion of scientific knowledge. The progress made by his pupils since the study of chemistry has been extended so as to become a branch of general education in the City of London School, is such as to warrant the assertion that Mr. Hall's efforts have kept pace with the increased demands of a larger number of pupils.

"(Signed)

"W. H. Perkin, F.R.S., Sudbury, Middlesex; John Spiller, F.C.S., Assistant Chemist in the War Department; Wm. Thorpe, jun., F.C.S., Rivers Commission Laboratory; C. W. Heaton, F.C.S., Professor of Chemistry in Charing Cross Hospital; Edmund A. Cook, Ph. D., F.C.S., Demonstrator of Chemistry in King's College, London; W. H. Deering, Chemical Department, Woolwich; Thomas Bloxam, F.C.S., Lecturer on Science, Cheltenham College; Wm. Cawthorne Unwin, B. Sc., A. Inst. C. E., Hemerton; J. James Ridge, B.A., B. Sc. L.R.C.P., M.R.C.S.E., London; William Spiller, F.C.S., Atlas Chemical Works, London; James Craik, Royal College of Science, Dublin; Henry Matthews, F.C.S., Analytical Chemist, 60, Gower Street, London; Edward Divers, M.D., F.C.S., Lecturer on Chemistry under the Committee of Council of Education in Ireland, and Lecturer on Chemistry at the Albert Veterinary College, London; Jas. T. Brown, F.C.S., Chemical Works, Greenford Green; Thomas Dale, M.A., Fellow of Trinity College and Examiner in Applied Science in the University of Cambridge; Edmund Ledger, B.A. Lond., M.A. Cantab., Rector of St. Peter's, Duxford; T. S. Aldis, B.A., Mathematical Master, Elizabeth College, Guernsey; Frederick Jas. M. Page, Royal School of Mines, London; Augustus Constable Maybury, Associate of the Royal School of Mines, B. Sc. Lond., M.R.C.S., &c., and Resident Medical Officer and Secretary to the Chelsea, Brompton and Belgrave Dispensary; Alexander Pedler, Laboratory, Royal Institution of Great Britain; Augustus A. Wood, F.C.S., Associate of King's College, London; Frank Clowes, Royal College of Chemistry, London."

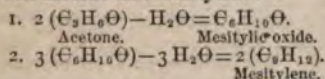
Chlorous Anhydride and Benzol.—L. Carius. The formation of trichlorphenomalic acid is accompanied by the production of chlorbenzol and dichlorquinone, more especially if an excess of chlorous acid has been used (*Ann. Chem. Pharm.*, cxlii., 129). The author thinks that this is due to a reaction between chlorous anhydride and benzol, which he represents in the following two equations—



As regards the properties of dichlorquinone the author confirms most of Städel's statements, but finds that the compounds obtained from it by the action of potassic or baric hydrate are not the salts of an acid similar to dichlor-

quinonic acid, but compounds of dichlorhydroquinone, $\text{C}_6\text{H}_4\text{Cl}_2\text{O}_2$.—(Ann. Chem. Pharm., cxliii, 315.)

Conversion of Mesitylenic Oxide into Mesitylene and $\text{C}_{10}\text{H}_{14}$.—A. Holtmeyer. Commercial acetone was saturated with chlorhydric acid, the mixture left to itself for a week, and then washed with water. The insoluble portions were dried and distilled, and the fraction boiling between 90° and 100° C. treated with alcoholic potassic hydrate. An oil was thus obtained from which at $128\text{--}130^\circ$ mesitylenic oxide distilled off. This oxide, after further purification, was mixed with half its volume of sulphuric acid, and after two days distilled. Two fractions were collected, one at $163\text{--}166^\circ$, one at 195° . The first was mesitylene—this shows that mesitylenic oxide occupies an intermediate position between acetone and mesitylene:—



The second, a hydrocarbon of the composition $\text{C}_{10}\text{H}_{14}$. This could be converted into the bromo- and nitro-compounds, $\text{C}_{10}\text{H}_{13}\text{Br}$ and $\text{C}_{10}\text{H}_{11}(\text{NO}_2)_2$; a sulpho-acid was also obtained, the baric salt of which corresponded to the formula $(\text{C}_{10}\text{H}_{11}\text{SO}_2\text{O})_2\text{Ba}$.—*Ibid.*, N.F., iii., 688.

Experiments with Dynamite.—This new blasting powder is meeting with flattering success in the hands of miners and quarrymen. The following account of some recent interesting experiments by the inventor himself, Mr. Nobel, of Hamburg, which we copy from the *Glasgow Journal*, will no doubt be read with great interest at this time. The experiments took place in Messrs. Fall's Ladywell quarry, and in the presence of a large number of civil and mechanical engineers, contractors, and quarrymen. Mr. Nobel commenced by showing the dynamite itself to be perfectly safe in use, by cutting a cartridge in two and burning one part, holding it in the hand all the time. The other half was shown to contain explosive material by the ordinary mode of firing it by percussion caps. Another experiment illustrating how safely it might be used was by throwing from the most elevated part of the quarry, about fifty or sixty feet high, a box filled with the powder. The box broke, and the dynamite was scattered about, but no explosion followed from the concussion. Another box, equally charged in the same way, was burned in a large open fire kindled on the ground, but no explosion followed. There was another experiment to illustrate the fact that the material might be exploded without enclosing it in a cartridge case or any confined place. It was laid on the end of a plank, and the percussion cap, on the end of a fuse, was made to explode in contact with the loose powder. The plank itself was shattered with a very loud report. Its power as a blasting agent was tested on the solid whinstone rock. One bore hole was made in the face of the rock, fourteen feet deep, fifteen feet from the face at right angles, and fifteen feet from the surface of the ground. The diameter of the bore was one and a half inch at bottom. This was charged with six pounds weight of the dynamite, and filled about four feet of the hole. The outer portion of the bore hole was stemmed loosely with sand. About 4,000 cubic feet of rock were actually displaced, and perhaps twice as much loosened. Another blast was made at the bottom, on the face of the quarry wall, nine feet six inches deep, and about one inch and a half in diameter at the bottom, which was charged with six pounds of dynamite; and this in what the foreman of the quarry had selected as the strongest rock that the quarry could supply him. The rock in this case was ruptured from the bottom to the very top, between forty and fifty feet in height. So thoroughly was it broken that the quarryman had simply to use the crowbars to remove the masses of rock. The workmen all said that gunpowder could not have produced such an effect. The utility of the dynamite for distress signals at sea was tested twice; in the first case with seven ounces, and in the second with about one pound into a cartridge, suspended from a cord

stretched across the quarry. On both occasions the report was very loud, the second of the signals being heard reverberating into the town. The power of the dynamite was also tested upon masses of wrought iron successfully. A large mass of wrought iron was fixed vertically in the ground, the top of which was nine inches in diameter, and distinctly convex. About five pounds of dynamite were placed upon the top, and an explosion effected. The result was the production of a distinct concavity, and an increase in diameter of nearly three-quarters of an inch, and ruptured all over the surface. In order to show the applicability of the dynamite for charging shells to be used with destructive effect upon iron-clads or casemated fortresses, a wooden cylinder with a three-inch bore was charged with dynamite and laid upon the side horizontally. Upon the bottom end of the cylinder was tacked a disc of tin plate. Opposite the tin plate, and about eighteen inches from it, were placed two pieces of boiler, three-eighths of an inch thick—being a cutting from some plates supplied by the Parkhead forge for Government contract. The strength of it, per specification, was twenty-four tons per square inch. The result was that with about eight ounces of dynamite, a piece of tin plate was projected through both pieces of boiler plate. Great satisfaction was expressed at the result of the experiments, both by the many practical persons who were present on the ground as visitors, and by the proprietors of the quarry and their workmen.—*American Journal of Mining*.

Chemical Promotions.—In our last we appended a note to "Chemical Promotions," (*Am. Repr.*, Sept. '68, page 167,) stating that Dr. Russell would probably fill the vacancy at St. Mary's Hospital. We have since been informed that other well-known chemists are in the field; from this it is evident that until the election has taken place it will be impossible to say who will fill the chemical chair in the room of Dr. Matthiessen.

Demonstratorship of Chemistry, King's College, London.—The post lately vacant by the resignation of Dr. Edmund Cook, who leaves for India, has been filled up by the appointment of Mr. J. T. Bottomley, M.A., of Queen's University, Ireland.

CONTEMPORARY SCIENTIFIC PRESS.

[Under this heading it is intended to give the titles of all the chemical papers which are published in the principal scientific periodicals of the Continent. Articles which are merely reprints or abstracts of papers already noticed will be omitted. Abstracts of the more important papers here announced will appear in future numbers of the "CHEMICAL NEWS."]

Comptes Rendus. June 15, 1868.

A. WURTZ: "On a new Isomer of Amylic Alcohol."—SECCHI: "Remarks on Prumowski's Note on the Spectrum of Brorsen's Comet."—A. TRIPLET: "On the Use of Anesthetics, in Attacks of Hapatic Colic."—F. DE CLERMONT: "On a new Alcohol isomerism with Caprylic Alcohol."—A. GAUVIER: "On the Carbamylamines."—E. FILLARD: "Researches on Chlorophyll."—A. SCHREIBER-KESTNER and C. MEUNIER: "Researches on the Combustion of Coal from Saarbrück, Rhenish Prussia."

June 22, 1868.

P. A. FAYRE: "Researches on Electrolysis" (Continuation).—P. DESAINS: "On the Use of a Pile of Plates of Rock Salt for Obtaining Polarised Heat in Researches on Obscure Radiation."—J. JAMIN and ROGER: "On the Laws of Induction."—SEDOT: "On the Preparation of Sulphides of Iron and Manganese."—P. ISAMBERT: "Researches on the Dissociation of certain Double Chlorides of Ammonium."

June 29, 1868.

DAUBREE: "Note on the Author's Work 'Synthetic Experiments on Meteorites.'"—SECCHI: "On the Spectrum of Winnecke's Comet."—G. MAGNUS: "On the Diathermancy of Chloride of Potassium."—L. DUBART and E. PELOUZE: "Contributions to the Knowledge of Phosphate of Lime."—A. HOZEK: "On the Action of Iodine of Potassium on Ether."—C. WOLF: "On the Spectrum of Winnecke's New Comet."—H. DEBBAT: "On the Vapour-Density of Colomet."—P. SCHUTZENBERGER: "Researches on the Action of Dry Hypochlorous Acid Gas on a Mixture of Iodine and Acetic Anhydride."—ROBINET: "On the Property possessed by Oxygen of causing Ignited Bodies to Flame."

Monatsbericht der Königlich Preussischen Akademie der Wissenschaften zu Berlin. March, 1868.

MAGNUS: "On the Polarisation of Heat of 100° , and on the Oscil-

lations which accompany the Conduction of Heat."—J. C. FORGESS: "On a Peculiar Instance of the Electric Conductivity of Glass."—HOFFMANN: "On the Composition of Persulphide of Hydrogen."

Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften zu Wien. (Mathematisch-Naturwissenschaftliche Classe.)

Division 2. January-February, 1868.
W. REITZ: "On the Passage of Cinnabar through the Animal Body."—E. MACH: "On the Effect of Different Modes of Lighting on the Apparent Form of Objects."—E. BRUCKE: "On the Detection of Ammonia in Animal Fluids, and on the Behaviour of the same in some of its Compounds."—A. WASEMUTH: "On the Currents in Secondary Combinations in Voltaic Batteries."—J. E. DE VRY and E. LUDWIG: "A Chemical Investigation of the Latex of *Antiaris toxicaria*."—ROCHLEDER: "Note on Pectous Substances."—A. BAUER and E. KLEIN: "Note on the Action of Tetra-chloride of Tin on Amylic Alcohol."—R. L. MALT: "Researches on the Colouring Matters of Bile."—A. HANDEL: "On a new Method of Observing Syphon Barometers."—A. BAUER and E. VERROSE: "Contributions to the Knowledge of Benzene."—E. HERRING: "Contributions to the Knowledge of the Vitality of Blood Corpuscles."

Bulletin de l'Académie Impériale des Sciences de St. Petersburg March 7, 1868.

P. ALEXEYEV: "Contributions to the Knowledge of Azobenzene."—F. BEHREND: "On Isomeric Dichlorotoluols and Trichlorotoluols."—DE JACOB: "Report on the various Processes for Electro-deposition in Use at J. M. van Kempen's Works at Voorschoten, with Particular Reference to a Method of Depositing a Silver Ornamental Vase in a Single Piece."

Journal für Praktische Chemie. May, 1868.
W. L. CLASSEN: "On the Action of Water and of various Neutral Saline Solutions on Cane Sugar."—C. SCHREIBER: "Note on the Presence of Metaplectic Acid in Electrode."—J. LOWE: "On the Formation of Ellagic Acid from Gallic Acid."—P. BOLLEY: "A Comparison of the Hygroscopic Properties of Raw Silk and of Silk which retains its Coating of Natural Gum. On the Adulteration of 'Tin Salts'."—On the Quantitative Estimation of the Unsaponified and Neutral Fat contained in Soups. Contributions to the Knowledge of Carcass. On a Green Dye-stuff from the Territory of Senegal, West Africa. On Peroxide of Manganese from Romanche, Saône-et-Loire, France. On some Properties of Paraffin, and on Paraffin Baths. On Obtaining Gallic Acid and Pyrogallol Acid from the Tannin of Sumach. On J. Fuchs's Process for Estimating Nitric and Nitrous Acid in Water. On E. T. Chapman's Remarks on Nessler's Test for Ammonia. On the Estimation of Potash in Alkaline Solutions. On the alleged Dryness in Spaces warmed by means of Hot Air, and on the Circulation of Air under such Circumstances."—WESELSKY: "On the Preparation of Double Cyanides of Barium."

June, 1868.
F. GÖPFELSDORFER: "On a Fluorescent Substance derived from Fustic, and on the Analysis of Fluorescent Substances in General."—R. L. MALT: "Researches on the Colouring Matters of Bile."

Bulletin de la Société Chimique de Paris. June, 1868.
E. BOURGEOIS: "On the Electrolysis of Malic Acid. On the Electrolysis of Benzoic Acid."—E. PERMY and TERREIL: "On a General Method for the Direct Analysis of Vegetable Tissues."—TERREIL: "On the Action of Saline Solutions on Minerals."—A. DESCAMPS: "On the Double Cyanides analogous to Ferrocyanides and Ferricyanides."—BERTHELOT and JUNGLEISCH: "Comparative Researches on Perchlorinated Benzene, Perchlorinated Naphthalene, and Jullin's Chloride of Carbon."—BERTHELOT: "On the Transformation of Dibasic into Monobasic Acids. On a Modification of the Author's new Thermometer for measuring High Temperatures. On Pyrogenous Hydrocarbons."—M. GALET: "A Simple Method of Removing Hydrochloric Acid from Commercial Nitric Acid."

Le Technologiste. June, 1868.
A. BAKER: "An Improved Process for Dyeing Turkey Red."—BERNARD: "On the same Subject."—A. CORDIER: "On the same Subject."—W. SCHULTZ: "Researches on the Formation of Lactic Acid during the Fermentation of Distillers' Worts."—A. Process for the Extraction of Silex from Black Copper."—REICHERT: "On Obtaining Magnesium from Carnallite."

Bulletin de la Société d'Encouragement. April, 1868.
PAYEN: "Report on Hugon's Apparatus for the Preservation of Wood by Superficial Charring and for the Disaggregation of Rocks by the Action of Heat."—Some new Methods of Preparing Permanganate of Soda."—MUTH: "On the Preparation of Pure Naphthalene from the Crude Products of the Distillation of Tur."—C. PESCHER: "A Cement for Attaching Brass to Glass."—T. WIMMEL: "On the Adulteration of Japanese Wax."—F. STOLBA: "On the Use of Paraffine in Crystallization Experiments. An Improved Cement."—G. C. WITTEIN: "On the Use of Sugar of Lead as a Glaze for Vitrifying Carbs."

Dingler's Polytechnisches Journal. May, 1868.
A. VON WALTENHOFFEN: "On the Amalgamation of Zinc Plates for Voltaic Batteries."—G. LUNGE: "On the Condensation of Hydrochloric Acid Gas in the Manufacture of Soda."—MARTIN: "On the Transformation of the Colouring Matters of Madder into Alizarine. Experiments on the Use of Cockschofers de Manure."

PATENTS.

Communicated by Mr. B. VAUGHAN, F.C.S., Patent Agent, 54, Chancery Lane, W. C.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

2176. J. B. Gregson, Gateshead, Durham, "An improved production of sulphate of lead to be used as a pigment or for other purposes."—Petition recorded, July 2, 1868.
2176. A. McNeill, Tiverton, Devonshire, and W. Wheaton, Exeter, Devonshire, "An improved process for the manufacture of salts of ammonia from ammoniacal gas liquor."—July 4, 1868.
2177. A. P. Price, Lincoln's Inn Fields, Middlesex, "Improvements in the treatment of phosphates of lime, and in obtaining products therefrom."—A communication from E. Pelouze, and L. Duport, Paris.—July 7, 1868.
2203. W. J. Hanson, Rawfolds, Cleckheaton, Yorkshire, "Improvements in dyeing wool or other fibrous substances."
2207. A. Munro, Arbroath, Forfarshire, N. B., and W. B. Adamson, Glasgow, N. B., "Improvements in the manufacture of iron and other metallic substances."—July 13, 1868.
2214. J. Bastow, Shepherd's Bush, Middlesex, "Improvements in bleaching or whitening textile fabrics, yarns, and thread made from flax, cotton, or other vegetable fibrous materials."—July 14, 1868.
2240. E. B. Wilson, Stockton-on-Tees, Durham, "Improvement in furnaces."—Petition recorded, June 24, 1868.
2251. J. Duguid, Jun., Glasgow, N. B., "Improvements in the manufacture of paper, and in the means employed therefor."—July 17, 1868.
2261. D. Webster, Southport Gas Works, Lancashire, "Certain improvements in the manufacture of gas, and in apparatus connected therewith."
2265. J. Thomas, Newcastle-on-Tyne, "Improvements in furnaces for smelting and melting."—July 18, 1868.
2277. T. G. Green, Church Gresley Pottery, Derbyshire, "Improvements in the preparation or manufacture of a composition intended to be used in the manufacture of earthenware, porcelain, or vitreous articles."
2278. L. Rose, Leith, Edinburgh, "An improved aerated liquid, or artificial champagne."—July 20, 1868.
2280. A. A. Wille, Woodford, Essex, "Improvements in bleaching or extracting the colour from feathers."—July 21, 1868.
2293. T. Gibb, Jarrow-on-Tyne, Durham, "Improvements in the treatment of metallic ores and compounds."
2294. G. Martin, Toadmoor Rock Mills, near Stroud, Gloucestershire, "Improvements in the manufacture of extract wool, and in the process and apparatus employed in destroying the vegetable material in mixed fabrics, which apparatus is applicable for other purposes."
2297. S. Langdale, Newcastle-upon-Tyne, "Improvements in the preparation of artificial manures."—July 22, 1868.
2314. P. Pearson, Leeds, "Certain improvements in the treatment and preparation of cocoa."
2321. J. Kilner, Wakefield, Yorkshire, "An improved method of and apparatus for manufacturing glass."—July 23, 1868.
2329. G. A. Thibierge, Versailles, France, "Improvements in preserving animal and vegetable substances."—July 24, 1868.
2308. L. Francis, New York, U. S. A., "Improved compositions applicable to printing purposes and the manufacture of printing materials and the production of emery cloth, artificial hones, and other polishing surfaces."
2312. J. E. Poynter, Glasgow, N. B., and T. L. Patterson, Greenock, Renfrewshire, N. B., "Improvements in obtaining or manufacturing saltpetre, iodine, and bromine."—July 2, 1868.
2314. A. Fryer, Manchester, "Improvements in the concentration and treatment of saccharine and saline solutions, and in apparatus employed therein."—July 4, 1868.
2316. J. F. Cooke, Cannon Street, London, "Improvements in the manufacture of copying ink."—Petition recorded July 8, 1868.
2317. J. Harris, Harefield Iron Works, Middlesex, and V. Pendred, Milton Road, Dulwich, Surrey, "Improvements in the manufacture of wrought iron and steel."—July 9, 1868.
2326. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the production of a red colouring matter."—A communication from A. Clavel, Basle, Switzerland.—July 22, 1868.
2334. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the manufacture of cast and wrought iron and steel, and in the furnaces employed therefor."—A communication from A. Ponsard and F. E. Boyenval, Paris.—July 24, 1868.
2343. L. Wray, Ramsgate, Kent, "Improved methods of, and apparatus for, obtaining or separating metals from their ores, matrices, slimes, and tailings."—July 25, 1868.
2357. A. M. Clark, Chancery Lane, "Improvements in the manufacture of artificial ice, and in apparatus for the same."—A communication from J. B. Toselli, Boulevard St. Martin, Paris.—July 27, 1868.
2364. J. Webster, Birmingham, "Improvements in the manufacture of gas and vapour, and in applying such gas and vapour in manufacturing and refining iron and other metals, and in recovering certain products therefrom."
2367. C. A. La Mont, New York, U. S. A., "An improved preparation of eggs."—July 28, 1868.
2375. E. Herring, Deer Lane, London, "Improvements in the treatment of saccharine solutions of malt or sugar."
2376. W. R. Lake, Southampton Buildings, Chancery Lane, "An improved compound to be used as a substitute for linseed oil in the

- preparation of paint and varnish."—A communication from R. E. Ferguson and B. B. Ferguson, Chicago, Ill., U.S.A.
2381. J. Radcliffe, Consett Hall, Durham, "Improvements in machinery or apparatus employed in the manufacture of iron and steel."
2384. J. Jeffreys, Upper Norwood, Surrey, "Improvements in preserving animal and vegetable substances."—July 29, 1868.
2396. T. Prosser, New York, U.S.A., "Improvements in distillation and in the means or apparatus employed therein."—July 30, 1868.
2404. A. G. Day, Seymour, Conn., U.S.A., "An improved artificial compound, chiefly designed for use as a substitute for india-rubber or caoutchouc."—July 31, 1868.
2405. J. F. Lackerstein, Cannon Street, London, "Improvements in means or apparatus for the preservation of organic substances."
2417. J. Heaton, Langley Mills, Derbyshire, "Improvements in the treatment of cast iron."—Petition recorded July 31, 1868.
2439. W. Spence, Quality Court, Middlesex, "Improvements in the treatment of auriferous, argentiferous, and other ores."—A communication from L. E. Rivot, Paris.
2441. H. A. Bonneville, Chaussée d'Antin, Paris, "Improvements in the process of dyeing textile materials, and in the apparatus connected therewith."—A communication from C. Corron, St. Etienne, France.—August 4, 1868.
2451. J. Hamilton, Chancery Lane, "Improvements in the manufacture of artificial fuel."
2453. A. V. Newton, Chancery Lane, "Improvements in the manufacture of iron and steel."—A communication from L. Silbert, Mount Solon; D. E. C. Brady, Buffalo Lodge; J. D. Imboden and S. M. Barton, Richmond, Virginia, U.S.A.—August 5, 1868.
2461. J. Hargreaves, Darlington, Durham, "Improvements in the manufacture of steel and iron, and in the preparation of materials and agents, and in apparatus to be employed therein."—August 6, 1868.

INVENTIONS PROTECTED BY THE DEPOSIT OF COMPLETE SPECIFICATION.

2440. C. D. Abel, Southampton Buildings, Chancery Lane, "A new or improved process for separating the zinc from the argentiferous alloys obtained in the separation of silver from argentiferous lead by means of zinc, and improvements in the furnaces employed for that purpose."—A communication from H. Roux, Marseilles, France.—Recorded July 25, 1868.
2468. W. K. Lake, Southampton Buildings, Chancery Lane, "Improvements in gine and in the mode of, and apparatus for, manufacturing the same, the said improvements being also applicable to the manufacture of gelatine and other material."—A communication from C. Wahl, Chicago, Cook, Illinois, U.S.A.—July 18, 1868.
2440. H. A. Bonneville, Chaussée d'Antin, Paris, "A new and improved process for preserving meat, and the apparatus connected therewith."—A communication from W. Wiesmann, Bonn, Prussia.—Petition recorded August 4, 1868.

NOTICES TO PROCEED.

978. G. F. Guy, Bury St Edmunds, Suffolk, "Improvements in the manufacture of sugar and other alimentary substances from beet-root."—Petition recorded March 22, 1868.
1045. A. Warner, Laurence Pountney Lane, London, "Improvements in the manufacture of cement."
1048. A. Scott, Blomfield Crescent, Paddington, Middlesex, "The production of an alcoholic fermented drink, sweet, or effervescent, of which tea or coffee or theine or caffeine is an essential ingredient."
1050. F. Bauman, Wellington Street, Strand, Middlesex, "The preparation of a certain combination of chemical substances, and its novel application to the treatment of wood or other fibrous material in the preparation of paper pulp."—March 27, 1868.
1187. V. Gallet, Lavauzelle de Benassais, Vienne, France, "Improvements in the manufacture of steel."—April 8, 1868.
1800. C. H. Wells, New York, U.S.A., "A new and improved mode of impregnating wood with oleaginous and saline matters."—A communication from W. A. Seely, New York.—June 1, 1868.
1076. A. B. Wollaston, Chislehurst, Kent, and F. Stanbridge, Llangarion, Herefordshire, "Improvements in the treatment of mixed fabrics, and in the separation of wool from cotton and other substances contained therein."—Petition recorded March 21, 1868.
1253. A. P. Price, Lincoln's Inn Fields, Middlesex, and J. A. Wanklyn, Finsbury Circus, "Improvements in the preparation and use of anaesthetics."—April 17, 1868.
1336. J. Rogers, Baxter Road, Islington, "Improvements in the preparation and utilisation of certain vegetable and bituminous products."—April 23, 1868.
1030. E. P. H. Vaughan, Chancery Lane, "Improvements in the preparation of anhydrous chlorides by means of sulphides or their elements."—A communication from P. Curie, Bordeaux, France.—May 19, 1868.
2048. Rev. H. Highton, M.A., Sussex Square, Brighton, Sussex, "Improvements in the manufacture of artificial stone or slate, and in colouring the same."—June 25, 1868.
2340. C. D. Abel, Southampton Buildings, Chancery Lane, "A new or improved process for separating the zinc from the argentiferous alloys obtained in the separation of silver from argentiferous lead by means of zinc, and improvements in the furnaces employed for that purpose."—A communication from H. Roux, Marseilles, France.—July 25, 1868.
1073. C. F. Claus, Middlesbrough-on-Tees, "Improvements in the manufacture of iron."
1074. C. F. Claus, Middlesbrough-on-Tees, "Improvements in the manufacture of malleable iron, and in the process of re-heating the same for the purpose of rolling or hammering it."—Petitions recorded March 30, 1868.

1117. J. G. Dale, and E. Milner, Warrington, Lancashire, "An improved method of producing white pigments from lead."—April 2, 1868.
1157. J. Radcliffe, Consett Iron Works, Durham, "Improvements in processes and means employed in the manufacture of iron and steel."—April 6, 1868.
1195. A. H. Still and D. Lane, Cork, "Improvements in the manufacture of gas."—April 9, 1868.
2261. D. Webster, Southport Gas Works, Lancashire, "Certain improvements in the manufacture of gas and in apparatus connected therewith."—July 18, 1868.
1167. A. L. Holley, Harrisburgh, U.S.A., "Improvements in the manufacture of iron and steel."—Petition recorded April 7, 1868.
1181. J. James, Ebbwvale, Monmouthshire, and T. Jones, Govilon, Monmouthshire, "Improvements in the manufacture of iron into semi-steel or steel."—April 8, 1868.
1422. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the manufacture of gelatine."—A communication from F. Coignet, Paris.—April 30, 1868.
1480. T. Warren, Glasgow, N. B., "Improvements in glass and other furnaces."
1489. M. Henry, Fleet Street, London, "Improvements in the manufacture of steel and iron, and other metals, and in furnaces employed in the said manufacture."—A communication from the Société Colnet et Compagnie, Boulevard St. Martin, Paris.—May 6, 1868.
1954. W. C. Sillar, Cornhill, London, R. G. Sillar, Upper Norwood, and G. W. Wigner, Camberwell, Surrey, "Improvements in deodorising and purifying sewage, and making manure therefrom."—June 15, 1868.
2440. H. A. Bonneville, Chaussée d'Antin, Paris, "A new and improved process of preserving meat, and the apparatus connected therewith."—A communication from W. Wiesmann, Bonn, Prussia.—August 4, 1868.

NOTES AND QUERIES.

A Question in Pneumatics.—Air is 850 times lighter than water, and the pressure of the atmosphere is sufficient to sustain a column of water 33 feet high. Now, if it were possible to submerge a quantity of air in the sea to a depth of 28,050 feet and then set it free, would the air still possess buoyancy, and would it rise to the surface of the water?—SCIENTIFIC AMERICAN.

Estimation of Sulphur in Pyrites.—Hypochlorous acid may be used to transform the sulphur of pyrites into sulphuric acid, which is then estimated by baryta. Finely pulverise the mineral and suspend it in water, through which a current of gaseous hypochlorous acid, or better still hypochloric acid, is passed; this entirely dissolves the pyrites. Hypochlorous acid is prepared by heating a milk of carbonate of lime through which a current of chlorine is passed to saturation: $\text{CaO} \cdot \text{CO}_2 + \text{HO} + \text{Cl} = \text{CO}_2 + \text{ClHO} + \text{CaCl}$. Hypochloric acid is obtained by heating in a water-bath a tube, supplied with a cork and delivery tube, and containing a mixture of 9 eqs. of oxalic acid and 1 eq. of chlorate of potash.—F. WOHLER.

Analysis of Spathic Iron.—Dissolve in hydrochloric acid, to which is added a little nitric acid or chlorate of potash. Precipitate with ammonia, but be careful not to filter until the liquid has been boiled till all odor of ammonia has disappeared; the iron then contains no trace of lime, magnesia, or manganese. The liquid containing no trace of free ammonia, the filtration may be performed in contact with air. The filtrate must be concentrated by evaporation, and the three bases which it contains precipitated with an excess of carbonate of potash, continuing the ebullition so long as no ammonia is disengaged. Filter the liquid and re-dissolve the precipitate in nitric acid, then evaporate to dryness and carefully heat to dull redness. Dilute nitric acid will then separate the lime and magnesia from the insoluble oxide of manganese.—F. WOHLER.

Aurine.—Printing Ink.—I observe in No. 451 of the CHEMICAL NEWS (*Am. Repr.*, Sept., 1868, page 171)—1st, that evidently from "R. G. B.'s" description he has not accurately read my short paper in No. 449 of the CHEMICAL NEWS (*Am. Repr.*, Sept., 1868, page 171); and, that the details given by me in that paper did not and need not enter into *minutiae* of manipulation required to bring out what I effectively did; 2nd, that "R. G. B." evidently overlooked what I stated about the unfitness of aurine pigments as oil colours, and hence also their unfitness to colour printing ink. Aurine and roseline are not synonimous terms, and aurine is not practically soluble in pure water. Resin oil, i.e., oil obtained from resinous substances, under peculiar manipulations, cannot advantageously replace the so-called drying oils in the manufacture of printing ink, since resin oil is not, by being exposed to a high temperature, converted into anhydride of linoleic acid, which is *de facto* the main constituent of good and genuine printing ink, and has been so for centuries.—Dr. A. A.

Can any correspondent of the CHEMICAL NEWS inform "NIXDEX" where he can obtain liquid carbonic acid, and the price of the same; also, where he can obtain second-hand philosophical apparatus?

Lubricating Composition.—In reply to "Aberkennig" (*Chem. News*, *Am. Repr.*, Sept., 1868, page 171), the best lubricating composition for heavy work is a mixture of railway grease and plumbago. A sailor introduced the above into the Portuguese navy; it proved efficacious, and the government granted him a pension. *HABST, BROOKER, & HABST.*
Gullipoli Oil.—Expose the oil to light and air; at the same time allow it to remain perfectly quiet for several days—if the oil be very foul, weeks may be necessary. It is a mere matter of time; the oil will surely become clear in the end—filtering through charcoal will slightly accelerate the operation. There are no dyes used in colouring wool

that will permanently stain oil. The aniline colours appear at first to colour oil, but in a short time are deposited, and the oil is as clear as ever. Query:—What will colour oil *permanently*, of any colour or shade, alkanet root excepted?—S. P.

Separation of Earthy Sulphates.—Prolonged digestion with a solution of carbonate of ammonia at the ordinary temperature will change sulphates of strontia and lime into carbonates, without acting on sulphate of baryta. A boiling temperature, or the employment of carbonate of soda, does not effect so complete a transformation. The mixture of salts so obtained should be finely pulverised and well washed in cold water before treatment with nitric acid; this then dissolves the strontia and lime and leaves the sulphate of baryta. Neutral lime salts treated with a solution of arsenious acid, give a precipitate of arsenite of lime on addition of ammonia. Salts of strontia and baryta under the same circumstances give no precipitate.—F. WÖHLER.

Naphthaline Yellow.—**Peat Charcoal.**—Can you tell me where I can procure a small quantity of naphthaline yellow? Also where I can obtain a cask of peat charcoal, and at what price?—J. N.

Spectroscope.—Will you kindly allow me to ask through the medium of your most useful "Notes and Queries," if the improved spectroscope designed by Professor Osborn, of Lafayette College, Easton, Pennsylvania, and noticed in the *CHEMICAL NEWS* of 14th February, p. 84 (*Am. Repr.*, April, 1863, page 199), is to be had in this country, and if so, where?—FRED. J. ROWAN.

Embalming.—I remember seeing an account of a method of embalming anatomical specimens in such a manner that their flexibility was not impaired, whilst the tendency to decompose was entirely prevented. I believe the vessels were first washed out with water, alcohol, and ether, and then injected with solution of tannin or some such substance. Can any of my fellow readers kindly supply more precise information and oblige?—A PHYSICIAN?

Yeast.—In the issue of the *CHEMICAL NEWS* for June 5, page 263 (*Am. Repr.*, Aug. 1863, page 66), there is a paper quoted from the *American Artisan*, on the "Adulterations and Falsifications of Bread." The second sentence reads "Under the influence of heat, water, and acid yeasts it often develops in that food cryptogamic vegetations." Will any of your numerous readers be good enough to tell me what is meant by acid yeasts, and what is that which is frequently added to ordinary yeast to make it quicker and more energetic as a ferment in dough?—A CONSTANT SUBSCRIBER.

Estimation of Antimony.—When antimony is precipitated in the form of sulphide, it is safest to convert it into antimonic acid of oxide of antimony (Sb_2O_3 , Sb_2O_5) by complete oxidation with fuming nitric acid in a weighed porcelain crucible. To avoid ignition, the substance must be moistened with a few drops of dilute acid before adding the fuming acid. A prolonged digestion effects the complete solution of the pulverulent precipitate of sulphur. The excess of acid is then evaporated off carefully, and the residue calcined.—F. WÖHLER.

Preparation of Sulphurous Anhydride.—A current of sulphurous anhydride is obtained by attacking, by means of copper, pure sulphuric acid, diluted with from half to two-fifths its volume of water. To make sure of the purity of the sulphurous anhydride I pass the current, at first through water contained in a large washing flask, then through two Woulfe's bottles: completely filled with pumice stone broken into small fragments and moistened. The moistened pumice stone, previous to its introduction into the bottles, is twice calcined with sulphuric acid, so as to free it from the chlorides and fluorides which it often contains. J. S. STARR.

Phosphate of Alumina in solution may be decomposed by adding bicarbonate of tin, boiling, and precipitating all the oxide of tin in combination with phosphoric acid, by means of sulphate of soda. The accuracy of this method has not yet been fully established. If sesquioxide of iron is also present in the liquid a certain quantity will be precipitated at the same time.—F. WÖHLER.

A Question in Agricultural Chemistry.—Some few years ago one or two landowners who had some wet, peaty land, formed into a committee, and drained it at a considerable cost. Their anticipations were very great, as, owing to the great quantity of humus, a continuation of good crops was expected; but, alas! to their dismay and cost, after the second and third seasons, they could not get a crop anything near the average—nay, there was not even sufficient grass to pay the expense of cutting it. Now, Sir, I would ask why there is such an exhaustion, and what are the elements most likely to be exhausted? Ammonia, nitrogen, phosphates, &c.?—AGRICULTURAL NOVICE IN CHEMISTRY.

ANSWERS TO CORRESPONDENTS.

NOTICE.—The American Publishers of THE CHEMICAL NEWS give notice that in accordance with a suggestion of MR. CROOKES, the Editor and Proprietor of the English publication, they will be pleased to receive and forward to him in London any scientific publications issued in America, for review—and also any Notes and Queries, Articles, Correspondence, etc., for publication or reply. Their facilities of communication with MR. CROOKES render this very desirable to all persons in the United States who wish to confer with him. Address,

W. A. TOWNSEND & ADAMS,
434 Broome Street, New York.

M. A. B.—Must excuse us for declining to enter into the controversy.

Ple-Juice is very good in its place, but it is not suitable for the pages of the *CHEMICAL NEWS*.

R. C. W.—We are much obliged for the extract and have made use of it.

Puzzled.—Messrs. Chalmers and Tatlock's paper on the estimation of potash, given in our pages in April last (*Am. Repr.*, June 1863, page 284), will give you the information you want about purifying platinum.

O. P. Q.—Our publisher informs us that the numbers are out of print.

Chemical Novica.—A letter is waiting for you at our office.

L. Pokorny.—We are acquainted with no better cement for iron than the well known mixture of iron filings, sulphur, and sal ammoniac.

Sea-Side.—A short account of the chemistry of shells appeared in Brande's "Manual."

H. Sicinstone.—The cinnamon stone is sometimes used as a gem. It consists essentially of a silicate of lime and alumina, containing a little iron.

Manager, G.—The substitution of lime, by zirconia in the oxyhydrogen light, has been carried out by the inventor, M. Caron, on a sufficiently large scale to show its entire practicability. The expense of zirconia would doubtless diminish as soon as a demand arose for it. It is a rare earth at present because nobody wants it.

W. A. Ross, Capt. R.A.—We regret that your communication is unsuitable for our pages.

Tessé du Motay.—A correspondent favours us with the following:—"The French Exhibition gives the address of Tessé du Motay as under:—Tessé du Motay & Karcher, à Metz, Moselle."

H. Deschamps.—In tempering articles of steel, a temperature of 430° F. is used for lancets, 530° F. for watch springs, and 590° for large saws.

A Physician.—We are aware that the statement has been made that solutions of arsenious acid are constantly employed by potheaters and others for: washing over poultry, game, &c., with the view of keeping them superficially fresh, but we do not believe it.

X. Y. Z.—We shall be very happy to allow you to refer to the book in question, and will let it remain at our office all next week. Being a rare book, we should be unwilling to lend it.

Puzzled.—The numbers have been regularly posted to the address you gave. None have come back here through the Dead Letter Office, so it is certain they were delivered properly.

W. Harcey.—Talc may be occasionally obtained in very clear pieces, 1 foot square, but not so clear as glass. Split thin, the sheets bend easily, but they will not stand rough usage, as they are scratched readily and easily flake off.

A. D. U.—If you will send a small piece of the deposit in a letter, we will tell you whether it is sulphate or carbonate of lime. Dilute acid will dissolve carbonate, but not sulphate. But "a reader of the *CHEMICAL NEWS* from the commencement," as you say you are, has profited very little by it if he is obliged to ask the Editor's advice in so very simple a case.

As.—Tersulphide of arsenic is not absolutely insoluble in water. Fresenius states that it dissolves in one million times its weight.

W. St. M.—The bill has been withdrawn; your letter, therefore, is not required.

Alpha.—No English book has been published on the subject.

J. Hardman.—The best information on the subject is probably to be found in Knapp's "Technology," by Richardson and Watts.

J. Reddrop.—A new edition of the work in question is in preparation, and will be published in the course of a few months. It will be in the New Notation.

W. James.—A warm aqueous solution of oxalic acid will immediately decompose phosphate of lime. Perhaps this reaction may be of use to you.

Olinthus.—Nickel is produced in large quantities at Birmingham. The exact details of its manufacture are kept secret, but it is by a wet process in which the property of carbonate of lime to precipitate metallic oxides is made use of to purify the metal from iron, arsenic, and copper. By regulating the temperature and precipitating fractionally, it is possible to remove all these metals from the solution, leaving the nearly pure nickel behind.

Communications have been received from Hirst, Brooke and Hirst; J. R. Haas & Co.; F. W. Hartley; M. A. Baines (with enclosure); C. Heisch (with enclosure); E. Tanner; J. A. Brande; J. Syme (with enclosure); D. Dalrymple; Hinds Howell; J. Crompton; F. Ignacio Rickard; F. Foord; Dr. R. Angus Smith, F.R.S.; G. W. Eccles; D. Powell; H. McLeod; Ivan C. Michels (with enclosure); Townsend and Adams; F. A. Pooley; J. Ireland, Jun.; W. Little; Mitchell & Co.; A. L. Stevenson; J. Cliff; and H. Bassett (with enclosure); Messrs. Townsend and Adams; Louis Pokorny; S. Mellor; Prof. Heaton; J. T. Dafter; F. A. Aramayo; W. Leighton; E. Smith; G. Dutton; F. J. Harker (with enclosure); M. A. Baines; Mawson and Swan; Prentice and Co.; J. L. Denman; R. Wardrop; J. Parry; Rev. B. W. Gibbons; Street Bros.; J. Noble; J. Bowring; J. Spiller; Spottiswoode and Co.; Dr. Rohrig; M. A. Whicelo; F. C. Calvert and Co.; Mottershead and Co.; J. Muspratt and Sons (with enclosure); E. Hunt (with enclosure); G. W. Eccles; E. Cotti and Co.; P. Equire; Dr. Horace Dobell (with enclosure); H. Yeates; E. Meldrum (with enclosure); J. Hardman; G. Pearson; Dr. T. Wood; D. T. Hughes, California (with enclosure); W. J. Wosfor; and Captain W. A. Ross, R.A.

Books Received.—"Condensed Temperance Facts for Christians, with remarks on Ancient and Modern Wines and Malt Liquors." By J. Mackenzie, M.D. London: Tribner. "Britain's Drawbacks." By Rev. Professor Kirk. "Water, its Impurities and Purification." By the London and General Water Purifying Company. "Development and present state of Dreher's Breweries." Vienna, 1863.

THE CHEMICAL NEWS.

Vol. III. No. 5. American Reprint.

ON SULPHOCYANIDE OF AMMONIUM.*

BY DR. T. L. PHIPSON, F.C.S., &c.

THIS is a salt which can be obtained in large quantities from the products of the distillation of coal. It accompanies the other compounds of ammonia in the ammoniacal liquor of gas-works.

In several works it is made to yield its ammonia for the production of sulphate of ammonia; for this purpose it is distilled with lime after the carbonate and sulphide of ammonium have been distilled.

For many years I have noticed that the sulphate of ammonia supplied to commerce for agricultural and other purposes often contains a small quantity of sulphocyanide, say from 2 to 4 per cent, but latterly a much larger quantity, which increases its yield in nitrogen when submitted to analysis without bestowing upon the product a corresponding value in an agricultural sense. For though the nitrogen of the ammonium in the sulphocyanide can be utilised like that in sulphate of ammonia, that contained in the form of sulphocyanogen escapes. In other terms only one half of the nitrogen in sulphocyanide of ammonium is available in the manufacture of artificial manures, since the other half is partly volatilised as sulphocyanhydric acid, and partly decomposed by the heat of the reaction, which is sometimes great enough to ignite the bisulphide of carbon resulting from the decomposition.

Within the last twelve months the quantity of sulphocyanide of ammonium present in some kinds of commercial sulphate of ammonia appears to have increased considerably, and several samples which I have examined recently have yielded upwards of 75 per cent of this salt; in fact, they were not sulphate of ammonia at all, but impure sulphocyanide of ammonium.

I found it necessary some time ago to discover a means of estimating rapidly and with accuracy the amount of this product when mixed with sulphate and chloride of ammonium and the various organic matters which usually accompany the commercial products.

Sulphocyanide of ammonium can be separated with tolerable accuracy from the sulphate by means of alcohol, in which it is freely soluble; but this method will not apply when chloride of ammonium is present also, nor does it give the sulphocyanide in a convenient form for weighing.

A method which I have satisfied myself gives very accurate results and is sufficiently rapid, consists in dissolving a given weight of the product in water, filtering, rendering the solution rather acid, and precipitating the sulphocyanogen as an insoluble salt of copper by the addition of equal equivalents of sulphate of protoxide of iron and sulphate of copper. The whole of the sulphocyanogen is eliminated in this manner. The copper compound is received upon a weighed filter, dried at 100° C., and weighed. It is anhydrous, and contains 2 equivalents of copper, 2 of carbon, 2 of sulphur, and 1 of nitrogen, — $Cu_2C_2NS_2$.

Having prepared a certain quantity of pure sulphocyanide of ammonium, I took the opportunity of studying some of its properties. Of these experiments I

will mention only those which appear not to have been made before.

Sulphocyanide of ammonium dissolves copiously in water and in alcohol, and these solutions offer considerable interest. In the first place, in dissolving rapidly in water this salt produces a greater degree of cold than any other compound with which I am acquainted. About half a litre of hot water being poured upon 500 grammes of the impure salt, I was surprised, on stirring the whole together, to find that hoar frost appeared immediately on the external surface of the vessel. The temperature of the solution was found to be between 2 and 3 degrees below zero, that of the hot water used 96°, showing that the temperature had sunk 98° or 99° C., in the space of a few seconds.

A substance which absorbs so much heat whilst dissolving would be expected to give out again much caloric when it crystallises, and such is the case. With saturated solutions the crystallisation is accompanied on this account with some curious phenomena. As one large crystal forms, the adjacent crystals are dissolved again by the heat produced, giving rise to a series of rapid movements in the liquid and along its surface. Some of these vibrations spread along the entire surface with the rapidity of lightning, and continue at short intervals until the whole liquid suddenly solidifies.

From concentrated solutions sulphocyanide of ammonium crystallises in large transparent plates of a slightly pearly aspect. These plates appear to be formed of long prismatic needles intimately united, and are best obtained with very concentrated solutions. When weaker solutions are caused to crystallise, right rectangular prisms are formed: they are often of great length; I have occasionally obtained them 2 or 3 inches long.

The alcoholic solution of sulphocyanide of ammonium presents in the highest degree the peculiar phenomena of supersaturation. A saturated hot solution after cooling will remain liquid for hours, probably for days together. But if the liquid is stirred with a glass rod it is immediately transformed into a mass of small crystalline plates. When, instead of a glass rod, a minute crystal of the salt itself is thrown into the supersaturated solution after it has become quite cold, at the same instant magnificent rectangular plates, having the four faces of the octahedron, begin to form rapidly upon the surface, and the vessel is soon filled with splendid crystals. The supernatant liquid separated from these can be made to deposit still a considerable quantity of small crystalline plates by being stirred rapidly for a minute or two with a glass rod.

A concentrated aqueous solution of sulphocyanide of ammonium has no action upon sulphur; but it dissolves a considerable quantity of iodine, and when the dark-coloured solution is diluted and heated, the yellow compound called "sulphocyanogen" is precipitated, and the liquid becomes colourless. Bromine acts in a similar manner. Each drop of bromine on falling into the warm solution produces a hissing noise; on boiling the liquid the sulphocyanogen compound is precipitated. These two precipitates are insoluble in alcohol and soluble in sulphuric acid like that which is produced by chlorine.

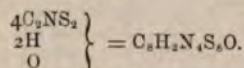
The action of chlorine gas upon solutions of sulphocyanide of ammonium is very remarkable. If the solution is dilute the sulphur is gradually oxidised to sulphuric acid, and no precipitate is formed. If concentrated, a dense precipitate of sulphocyanogen occurs after a lit-

* British Association, Norwich Meeting, Section B.

the while. It is difficult to obtain the whole of the cyanogen in this form, even when the liquid is kept near its boiling point the whole time. When the decomposition is complete and the liquid separated from the precipitate is evaporated, it yields chloride of ammonium. The action of chlorine on this solution is yet incompletely known. The composition of the so-called "sulphocyanogen" has been much discussed. For some time this precipitate was considered to be the radical of sulphocyanhydric acid, but it was afterwards found to contain hydrogen and oxygen. The composition assigned to this substance by Laurent and Gerhardt, namely 3 equivalents of cyanogen, 1 of hydrogen, and 6 of sulphur, appears to be inadmissible. The results of my analysis of this compound correspond with those of Vökel, not with those of Laurent and Gerhardt. It should be stated, however, that Charles Gerhardt, to whom organic chemistry owes so many splendid investigations, whilst criticising Herr Vökel's labours on sulphocyanogen, based his own opinion in this case upon an incomplete analysis of the substance in question. The product can be completely purified by washing with hot water and with alcohol should it contain any persulphocyanhydric acid, which seldom occurs, or when it does happen to be present is generally in too small a quantity to affect the results of the analysis. The dried precipitate is anhydrous. It has yielded—

	T. L. P.	Vökel.	Calculated.
C.....	20.00	19.93	19.83
H.....	0.78	1.08	0.82
N.....	23.20	23.31	23.14
S.....	53.00	52.68	52.48
O.....	3.02	3.00	3.73
	100.00	100.00	100.00

This composition corresponds with the formula $C_6H_2N_4S_6O$, admitted by Herr Vökel, and not with that of Gerhardt, which requires 24 per cent of nitrogen and nearly 55 of sulphur; it contains the elements of 4 equivalents of sulphocyanogen, 2 of hydrogen, and 1 of oxygen.—



The insoluble copper salt above mentioned was suspended in boiling water, whilst a current of chlorine gas was passed through the solution, with the expectation of obtaining sulphocyanogen itself, but little or no decomposition ensued; when iodine was substituted for chlorine the copper compound was partially decomposed, with production of some iodide of copper and an odour of iodide of cyanogen.

In conclusion, I may add that as the products derived from sulphocyanide of ammonium are very numerous, it is not impossible that some of them may eventually be applied to some useful purpose; if so it will be satisfactory to know that we possess a supply of this salt as inexhaustible as that of coal itself.

NOTE ON THE PREPARATION OF SOME ANHYDROUS SO- DIUM DERIVATIVES OF THE SALICYLIC SERIES.*

BY W. H. PERKIN, F.R.S.

In the preparation of salts or other metallic derivatives

* *British Association, Norwich Meeting, Section B.*

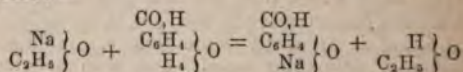
of organic bodies by means of oxides, there is always an equivalent of water produced, unless the substance acted upon be an anhydride; therefore, if the resulting compound has any tendency to form hydrated products, such are nearly sure to be produced, and it often happens that it is difficult or impossible to remove this combined water. Having to prepare a quantity of hydride of sodium—salicyl (salicylate of sodium) in an anhydrous state, it appeared to me that if I could obtain it anhydrous at once that I should avoid that blackening and loss which this salt is subjected to unless dried very rapidly.

I first thought of dissolving sodium in the anhydride; but such a process is unmanageable, and could not yield a pure product.

It then appeared to me if I could work with absolute alcohol in place of water, that I might obtain this result, but then what was to be substituted for the metallic oxide? Sodium-alcohol was proposed, as it would yield only an equivalent of alcohol when decomposed, instead of an equivalent of water; with this product I succeeded perfectly.

To prepare the anhydrous hydride of sodium-salicyl, it is only necessary to dissolve a weighed quantity of sodium in about twenty or thirty times its weight of alcohol, and then to add the theoretical amount of hydride of salicyl, also mixed with alcohol. If these solutions are added hot the mixture will enter into ebullition, and beautiful golden scales of the new product crystallise out. After standing for about half an hour the new salt is filtered off, washed once or twice with alcohol, pressed between bibulous paper, and placed in the water oven, where it will be found to dry in a comparatively short time. Thus obtained the hydride of sodium-salicyl is of a beautiful primrose yellow colour. Sodium determinations of this product gave numbers showing it to be perfectly pure.

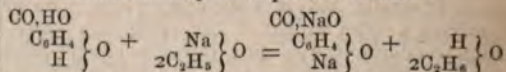
The reaction by which it is formed may be thus expressed:—



On treating salicylic acid in a similar manner, using 2 equivalents of sodium to 1 equivalent of acid, a beautiful white salt, crystallising in needles is obtained. This, when dried and analysed, was found to be a di-sodium derivative—salicylic acid with both its acid and phenolic hydrogen replaced by sodium—it therefore corresponds to that series of salts obtained by Piria, and which led chemists to believe salicylic acid to be bibasic.

This salt is deliquescent and possesses a very alkaline reaction; it is very soluble in water.

Its formation may be expressed thus:—



This salt will doubtless be found a useful reagent when it is desired to substitute both these replaceable hydrogens of salicylic acid by radicals.

The corresponding potassium derivative prepared with potassium alcohol is not so easy to obtain as the sodium one, owing to its easy solubility in alcohol.

I have also obtained a very peculiar sodium derivative of salicin by treating it with an alcoholic solution of sodium alcohol.

When these bodies are mixed together and stirred the salicin dissolves, but after the lapse of a short time a slightly crystalline powder forms and soon renders the

mixture quite pasty. On washing this product with alcohol and then drying it gently in the water-oven, it is obtained as a white, rather friable mass. Analysis of this body has shown it to consist of salicin with an equivalent of hydrogen replaced by sodium:—



Although I have experimented with an excess of sodium alcohol, yet I have not been able to introduce a further quantity of sodium into salicin.

I have made similar experiments with gallic acid, but although the product always contained a very great deal more sodium than a normal gallate, yet I have not been able to obtain a definite product. This would appear to result from the insolubility of the salt in alcohol, as it is precipitated before the solutions can be well mixed, and is therefore not homogeneous in composition. It is possible that potassium alcohol would yield a better result.

ON THE ACTION OF NUCLEI IN INDUCING CRYSTALLISATION.*

BY CHARLES TOMLINSON, F.R.S.

IN introducing this subject to the Chemical Section of the British Association, Mr. Tomlinson stated that it formed the subject of a note sent in to the Royal Society, as an addendum to his paper read before that body on the 28th May last, on "Supersaturated Saline Solutions."†

On that occasion it was noticed by one of the Fellows that some tubes, containing supersaturated solutions, exhibited by Mr. Tomlinson, had a saline crust just above the liquid surface, arising from a portion of the water of the solution evaporating through the cotton wool with which the tubes were plugged. It was stated that this saline crust did not act as a nucleus to the remainder of the solution, because, according to Mr. Tomlinson's theory, it was chemically clean. The objection raised was, that in cases of ordinary crystallisation, as in nursing a crystal of alum for example, we must be dealing with chemically clean surfaces during the growth of the crystal. The answer to this objection is that in the case referred to none of the conditions of chemical purity are observed; the evaporating dish is not chemically clean, nor is the solution exposed to the air, nor is the air by which the crystal is suspended, nor is the crystal, for this is frequently taken out and exposed to the air, and abnormal growths are chipped off with the thumb-nail. If all the conditions of chemical purity could be ensured, it is probable that a crystal let down into a highly saturated solution of the same salt would not act as a nucleus to it. The solution would, according to this theory, adhere to it as a whole, and being saturated or supersaturated, would not dissolve it.

To test this opinion, Mr. Tomlinson prepared, with very great care, a solution of the magnesia sulphate (two parts by weight of salt to one of water), which was filtered while boiling into a chemically clean flask in which the solution was again boiled, and while steam was issuing from the neck, a short wide tube attached to a wire, filled with crystals of the salt, all made chemically clean, was suspended in the neck, which was plugged with cotton wool at the same time that the lamp was removed. The whole was left du-

ring about fifteen hours, when the tube with its crystals was gently lowered into the solution. There was no action of the crystals as nuclei, and they were left in the solution for 48 hours without any change taking place.

A similar solution was put into clean test-tubes plugged with cotton wool. The tubes were placed in sulphuric acid and covered with a receiver, from which the air was pumped out. In about twenty minutes a crystalline crust formed on the surface of the liquid which, during the shaking of the air pump, fell through the solution to the bottom, but it did not act as a nucleus. On removing the tubes and taking out the cotton wool the solutions immediately became solid from the entrance of some mote or dust floating in the air, which being chemically unclean acted as a nucleus.

The reading of Mr. Tomlinson's paper excited a lively discussion, in which the President (Dr. Frankland), Professor Williamson, Dr. Gladstone, Mr. Crookes, and others took part. They all wished for a definition of a dirty surface in contradistinction to a chemically clean one, Professor Williamson calling to mind the old adage as to dirt being merely "something in the wrong place." Mr. Tomlinson remarked in reply, that the various effects explained by his theory would hereafter be referred to a general law of adhesion; that there were a large number of facts at present much obscured by theory which admitted of easy explanation on this principle of chemical purity; that the investigation was a long one and was now in progress; but to give some idea of what may be understood by a chemically unclean surface and its mode of action, as compared with a chemically clean surface, dip a glass rod made chemically clean into soda-water; there will be no separation of the gas, because the solution will adhere to it as a whole; draw the glass rod through the hand slightly oiled or greasy, and then dip it into the soda water; it will be completely covered with gas, since there is an adhesion between a gaseous and an oily surface, while there is none between water and an oily surface. In like manner bodies that are exposed to the air contract an organic film from the condensation of the products of respiration and combustion, which film will adhere to the saline or gaseous particles of a solution, but not at all, or only imperfectly so, to the water of such solution. Hence there is a separation, and bodies are said to be active as nuclei when they have been exposed to the air, when in fact they have only become contaminated.

ON THE CHEMICAL COMPOSITION OF THE GREAT CANNON OF MUHAMMED II.,

RECENTLY PRESENTED BY THE SULTAN ABDUL AZIZ KHAN
TO THE BRITISH GOVERNMENT.*

BY F. A. ABEL, F.R.S.

THIS interesting example of heavy ordnance of early date, which has recently been added to the Museum of Artillery at Woolwich, is one of the large bombards which have, for about four centuries, occupied positions in the batteries on the Dardanelles. There appear, as recently as 1829, to have been upwards of sixty of these great cannon, but at the present time only

* British Association, Norwich Meeting, Section B.

† See CHEMICAL NEWS, vol. xviii., p. 2. *Ann. Repr.*, Sept. 1863, page 114.

* British Association, Norwich Meeting, Section B.

eighteen are extant, several of which are of still larger calibre than the one now at Woolwich.

This one and other four of the bombards are referable to the period of Muhammed II., and an interesting account of the manufacture of these great pieces of ordnance, extracted from the MS. of a contemporary writer, is given by General J. H. Lefroy, R.A., F.R.S., in a paper on this gun and other great oriental cannon, recently read before the Royal Archaeological Institute. These pieces of ordnance are specially interesting as constituting the only examples of guns which have continued to be applied to defensive purposes for four centuries. They are not mounted upon carriages, but rest upon oak-sleepers and are backed by strong walls, with the view of preventing their recoil when fired. Each gun can, therefore, only be brought to bear in one direction; nevertheless a remarkable illustration of their destructive powers, when applied even in modern engagements, was afforded upon the passage of the Dardanelles by Sir John Duckworth's squadron in 1807, when six vessels were struck by their means, a great number of men being killed and wounded.

The gun recently deposited at Woolwich bears the following inscriptions, which have been deciphered by Mr. Redhouse:—

1. Help, O God, the Sultan Muhammed Khan, son of Murad.
2. The work of Minver Ali in the month Rejeb.
3. In the date of the year Eight hundred and sixty-eight (A.D. 1464).

An additional more modern inscription, near the vent, states that the weight of the shot is 240 okes (679 lbs.); powder due, 17½ okes (49½ lbs.); degrees, 3. Some spherical stone shot received with the gun weigh 670 lbs.

The gun consists of two parts, which are screwed together: each part weighs about 9 tons, the total weight of the piece being 18 tons 14 cwt. 3 qrs. Its external form is cylindrical, the muzzle being as large as the breech; each end of either separate part carries a projecting moulding which is divided by cross-bars into recesses. The object of these was not simply ornamental; the recesses obviously serve the purpose of the holes in a capstan-head, being required to give purchase to the levers employed in screwing the two parts together, and in moving the gun. Each piece has some simple moulding-ornamentation at the ends, and the external surfaces are subdivided by rings or mouldings about 14 inches apart. The total length of the gun is 17 feet, the diameter of the powder-chamber is 10 inches, that of the bore is 25 inches. The two screws which join the pieces together, and are 23 inches in diameter, are skilfully cast.

Specimens of the alloy composing this interesting cannon were detached for analysis from the mouldings or projecting rims which exist at either end of each part of the cannon. The metal was found to be more or less thickly coated with suboxide of copper, which had here and there passed into carbonate. In some parts where porosity of the metal had been considerable, the oxidation had proceeded to depths ranging from 0.2 to 0.5 inch, and even upwards. The alloy was found to vary greatly in hardness, and most of the small specimens detached were porous, and differed from each other considerably in colour. Some presented the usual appearance of gun-metal of good quality (e. g. samples I. and IV.); in their immediate vicinity were found patches of white alloy (samples IA. and II.) rich in tin, such as are observed occasionally in bronze castings, in

which the mixture of metals has been imperfect, or which have been allowed to cool very slowly; again, other portions (samples IIIA. and V.) more nearly resembled pure copper in colour and were comparatively very soft.

The proportions of copper and tin in the several specimens analysed are as follows:—

<i>From the Moulding at Rear-end of the Breech-piece.</i>		
I.		IA.
		(In close proximity to I.)
Copper	92.00	89.58
Tin.....	7.95	10.15
<i>From the Moulding at Front-end of the Breech-piece.</i>		
II.	III.	IIIA.
Top of moulding.	Side of moulding.	
Copper	90.57	93.70
Tin	9.75	6.23
		5.60
<i>From the Moulding at Rear-end of the Chase.</i>		
	IV.	
Copper	91.22	
Tin	8.49	
<i>From the Moulding at the Muzzle.</i>		
	V.	
Copper	95.20	
Tin	4.71	

Samples I. and IV. approach closely in composition to the best description of gun-metal of recent manufacture; Nos. IA. and II., which are comparatively rich in tin, exhibited specks of white alloy interspersed through the masses. Nos. III., IIIA., and V. contain higher proportions of copper than have been found in any other specimens of ancient gun-metal, the results of which have been published. Thus, the large Bhurtpore gun at Woolwich, which was cast in 1677, contains from 60.5 to 86 per cent of copper in different parts of the gun;* a large bronze gun, also at Woolwich, one of four which were cast at Florence in 1750, contains 89 per cent of copper and about 10 per cent of tin.† The Maliki Mydax, or great gun of Bujapore, which was cast in 1548, is stated to contain only 80.42 per cent of copper and 19.57 per cent of tin; and the Dhool Dhanee, or great gun of Agra, which was cast in 1628, contains, according to the analyses made by the Assay Master in Calcutta in 1832, 92.7 per cent of copper and 7.3 per cent of tin near the muzzle, and 88.3 per cent of copper to 11.7 per cent of tin near the breech.

The great guns of the Dardanelles appear to have been produced from the metal of small cannon, and there is little doubt that no approach to an uniformity of mixture of the alloys composing those cannon could be attained with the crude means at command for melting the metal. It is, however, interesting to note that, in the seven specimens taken from the great gun now at Woolwich, which have been analysed, only traces of other metals than copper and tin have been discovered. Lead and iron were detected in minute quantities, and traces of antimony and arsenic were also discovered; but a careful examination of the specimens for gold, silver, and zinc failed to furnish any indication of the presence of these metals.

ANALYSIS OF THE ANCIENT-ROMAN MORTAR OF THE CASTRUM OF BURGH, SUFFOLK.†

BY JOHN SPILLER, F.C.S.

A MORE than antiquarian interest attaches to the re-

* Abel on the composition of some interesting cannon. *Philosophical Magazine*, vol. 23, p. 181.

† Ibid., page 184.

‡ British Association, Norwich Meeting, Section B.

mains of Roman constructive work in this country, from the circumstance that they appear to have withstood the ravages of time much more successfully than most of the Norman and mediæval architectural monuments reared in much later periods. This superiority has been generally attributed to great simplicity in points of construction, together with the use of imperishable materials, such as flints and rubble, and to a skilful preparation of the mortar employed to bind the stones together.* I was so much struck with the hard and enduring character of the Roman mortar used in the construction of Burgh, that I was induced to bring away with me a few samples for analysis on the occasion of my visiting the castrum in the years 1863 and 1866. The results of the chemical examination of these specimens are appended, but before proceeding to discuss the question of composition it would seem desirable to indicate briefly the circumstances of their occurrence.

Burgh Castle, Suffolk, the *Garianonum* of the Romans, is situated on an eminence near the junction of the rivers Yare and Waveney, and about five miles from Yarmouth. It is a mural erection in the form of an immense parallelogram, of which one side is wanting, being left unprotected on the river front. The massive walls are strengthened at the angles and at certain intermediate positions by towers or solid cylinders of masonry which are uniform in height with the rest of the work (i.e., about 15 feet), and measure from 40 to 50 feet in circumference, being larger at the top, and only in the case of the two corner towers being truly circular in form. The length of the wall on the eastern side, which is perfect throughout, with gate in the centre, I found to be 650 feet; whilst the north and south walls have fallen away in places, but their length may be roughly stated at 350 feet. The appearance of the whole is grand and highly picturesque; the walls, which are of rubble masonry, and about 6 feet in thickness, are faced with flints and layers of red tiles set at intervals with great regularity, and the contrast of colour is heightened by parts of the work being overgrown with moss and ivy. The flints are arranged in tiers of four and occasionally five courses, and the red tiles invariably occur in triple layers with seams of mortar between; this order of construction is repeated some five or six times from base to rampart, with a cap of flints at the top, and the round towers or abutments present the same construction as the rest of the work. The walls vary in thickness, being, as already stated, generally about six feet, and are constructed internally of compact rubble, the stones being large and the mortar presenting throughout the reddish colour,—due to admixture of pounded brick,—which is considered to be characteristic of a Roman origin. The red tiles are of very fine texture, well burnt, and compact, for none of them appear to have been disintegrated by frost; their dimensions are tolerably uniform only as regards thickness, from $1\frac{1}{2}$ to $1\frac{3}{4}$ inch, and they extend to various distances within the face of the wall, in some places 12 inches only and at others nearly twice that depth.

With respect to the probable antiquity of the structure I have been favoured with an opinion from Mr. C. Roach Smith to the following effect:—"These fortresses (Richborough, Lymne, Pevensey, and Burgh) instead of having been built at the early date popularly assigned to them were erected at a comparatively late period in the Romano-British epoch, to defend the coast against

the incursions of the Saxons." It would appear, then, that at least fifteen centuries have elapsed since the foundations of these castra were laid * and with the well authenticated knowledge that the Romans were conversant with the properties of burnt and slaked lime, and employed the latter in making their mortar, we have obviously the means of testing the action of time and atmospheric influences upon this hydrate placed in contact with sand and other silicious substances for lengthened periods. It becomes, then, important to ascertain the following chemical points in reference to the hardening of mortars:—

1st. To what extent the hydrate of lime becomes re-carbonated by exposure to air?

2nd. What is the physical condition of the carbonate so produced? and

3rd. Whether in this long interval the silica and lime can directly unite with each other?

Different views on this subject have been advanced, the prevailing opinion undoubtedly being that the lime never becomes thoroughly re-carbonated, but stops short at a point when a definite combination of hydrate and carbonate of lime is formed; and, secondly, that lime is endowed with the power of attacking sand and other forms of insoluble silica by long contact at the common temperature.†

The conclusions to which I have been led by the chemical examination of the ancient mortars from Burgh, Pevensey, and other Roman castra, is that the lime and carbonic acid are invariably united in monatomic proportions, as in the original limestone rock; and that there is no evidence of the hydrate of lime having at any time exerted a power of corroding the surfaces of sand, flint, pebbles, or even of burned clay, with which it must have been for lengthened periods in contact. Further, that the water originally combined with the lime has been entirely eliminated during this process of re-carbonation; and, this stage passed, the amorphous carbonate of lime seems to have become gradually transformed by the joint agency of water and carbonic acid into more or less perfectly crystallised deposits or concretions, by virtue of which its binding properties must have been very considerably augmented. It is proper to state that Messrs. Abel and Bloxam‡ assign as one of the causes of the hardening of mortars, the formation and subsequent crystallisation of the carbonate of lime.

Reserving for the present the details of analysis of other Roman mortars, which in the main corroborate the results obtained in the examination of the specimens from Burgh, I have only to mention, as regards the process, that hydrochloric acid diluted with ten times its bulk of cold water was used for dissolving out the calcareous ingredients and leaving intact the sand and brick particles. Much of the latter was then separated by hand-sorting, and the weight of the remainder was deduced from the observed amounts of alumina and peroxide of iron obtained by fusion of the residue, after a special analysis had demonstrated the relation of these mixed oxides to the silica in the red brick. All pebbles weighing ten grains and upwards were excluded from the sample, these being deemed constitu-

* *Vide* "The Antiquities of Richborough, Reculver, and Lymne," by C. Roach Smith, pp. 153, 179.

† *Vide* Knapp's "Technology," edited by E. Ronalds and T. Richardson, vol. II., p. 306 and seq. General Gillmore's "Practical Treatise on Limes, Cements, and Mortars," New York, 1863, pp. 174, 186. Mr. G. E. Burnell's "Rudimentary Treatise on Limes, Cements, Mortars, &c.," p. 49.

‡ "Handbook of Chemistry," p. 296.

* *Vide* C. Roach Smith's Report on "Excavations at Pevensey," 1858, pp. 12, 14.

ents of *concrete* rather than of builder's *mortar*. The grains of sand were sharp and angular, and the mode of searching for soluble silica was briefly as follows:—A large quantity of the Roman mortar was placed in contact with the diluted hydrochloric acid until all the lime was taken into solution as chloride of calcium. The physical character of this salt not permitting of the detection of soluble silica by direct evaporation of the liquid, I had recourse to the following expedient for concentrating any soluble silica which might be present in solution:—Ammonia was added until the reaction to test-papers became faintly alkaline, the result was the precipitation of mixed alumina, peroxide of iron, and a small quantity of carbonate of lime. This flocculent precipitate being filtered off retained all the soluble silica in combination, and being again dissolved in hydrochloric acid and evaporated to dryness with a small addition of pure chloride of sodium, left the whole of the contained silica insoluble upon digesting with acid. The accuracy of this method of proceeding was tested by preliminary trials with samples of Portland cement, both in the freshly burnt condition and after setting under water. The amount of soluble silica in the Burgh specimens was exceedingly small (0.4 per cent), proving that a "fat" lime was originally employed by the Romans, and that the lapse of centuries has failed to induce any kind of action from which the silication of the mass may be inferred.

To support my assertion that the lime has simply become converted into carbonate, I may mention that a special search for caustic lime by the nitrate of silver test failed to indicate its presence, whilst all recent mortars show an abundant precipitate of the brownish-grey oxide of silver; that the Roman mortar triturated with pure water gives no alkaline reaction with turmeric paper; and further, that the proportion of carbonic acid found in the Burgh samples is, within the limits of experimental error, exactly the amount which is required to combine with the lime in order to form the neutral carbonate. I would remind those who are inclined to place reliance on the statements regarding the silication of old mortars, that the proof is often wanting that the lime was itself free from soluble silica at the time of employment. Inferences can only be safely deduced from cases where there is clear evidence of a "fat" lime having been actually employed in the fabrication of the mortar, for so many varieties of lime, having modified hydraulic properties and gelatinising with acids, are known to result from the simple burning of blue lias and other argillaceous limestone rocks, that the absence of soluble silica at the first moment of preparation should not be always assumed.

Analysis of the Roman mortar and of the red bricks, or tiles, gave me the following results:—

Roman Mortar from S.E. Tower, Burgh.

	I.
Sand	54.50
Soluble silica	0.40
Red brick with some unburnt clay ..	18.00
Carbonate of lime	25.75*
Sulphate of lime	0.15
Carbonate of magnesia	0.08
Chloride of sodium	0.05
Magnetic oxide of iron	traces
Wood charcoal	traces
Water, chiefly hygroscopic	0.92
	99.85

* Found, lime 14.5, carbonic acid 11.25 per cent.

Other Samples of Burgh Mortar.

	II.	III.	IV.
Sand and brick with a little unburnt clay	72.3	71.4	67.0
Carbonate of lime, &c. (by difference)	27.7	28.6	33.0

Samples II. and III. taken from the south wall. Specimen IV. from the north wall.

Red Brick or Tile from S.E. Tower, Burgh.

Silica	72.7
Alumina	14.0
Peroxide of iron	10.0
Lime	2.1
Magnesia	traces
Oxide of manganese	traces
Alkalies and loss	1.2
	100.0

In conclusion I would remark that the microscope very clearly demonstrates the mamellated crystalline character of the linings of cavities and other calcareous parts of the Burgh mortar; and further, that my results are in general conformity with the analyses of ancient Roman, Greek, and Phœnician mortars published three years ago by Dr. W. Wallace in the *CHEMICAL NEWS* (Vol. xi., p. 185, *Eng. Ed.*).

REPORT ON THE CHEMICAL NATURE OF CAST IRON.*

PART I.—ACCOUNT OF SOME EXPERIMENTS MADE TO OBTAIN IRON FREE FROM SULPHUR.

BY A. MATTHIESSEN, F.R.S., AND S. P. SZCZEPANOWSKI.

FOLLOWING out the plan indicated in the preliminary report presented to the Association in the year 1866, we have been endeavouring to prepare pure iron, but have encountered greater difficulties than we expected, owing to the great affinity which iron has for sulphur. Although we have not been able as yet to prepare iron absolutely free from sulphur, yet the results, as far as they have been obtained, may be of interest to the section, and a brief account of them is given in the following pages.

In the endeavour to prepare pure iron, we always found sulphuretted hydrogen on dissolving the metal in dilute hydrochloric acid. This small quantity of sulphur contained in the iron did not proceed from the hydrogen, or from the platinum tube in which the oxide was reduced. The manner of preparing the pure hydrogen, and the precautions taken with the platinum tube, will be described hereafter.

The first series of experiments were made by precipitating the hot, concentrated, clear solution of proto-sulphate of iron by oxalate of ammonium, washing the precipitate till the wash-waters no longer indicated sulphuric acid with chloride of barium, heating the dried oxalate of iron to redness in a platinum dish, and reducing the oxide thus obtained in a platinum tube. The reduced iron contained sulphur. In all the experiments we describe, sulphur was tested in the following manner:—The iron was placed in a test-tube with some dilute pure hydrochloric acid, and the gases were allowed to pass through a small tube fitted into a cork in the test-tube, and to impinge on a paper moistened with acetate of lead. The evolution of sulphuretted

* British Association, Norwich Meeting, Section B.

hydrogen, after a very little experience, moreover, is just as easily detected by the smell.

Experiments were also made with the oxalate of iron by re-dissolving it in hydrochloric acid and re-precipitating with ammonia, or by dissolving the oxide obtained by heating the oxalate of iron in hydrochloric acid, and re-precipitating again by oxalate of ammonium. In all these cases the reduced iron contained sulphur.

The second series of experiments were made with the iron obtained from the crystalline oxide of iron.—It is well known that when protosulphate of iron is fused with chloride of sodium a crystalline oxide is obtained. For our experiments it was of course necessary to perform this operation in a platinum crucible, but it was found that the iron thus obtained contained a small quantity of platinum. We therefore employed, instead of chloride of sodium, the sulphate of sodium, and obtained an oxide which, after having been thoroughly washed and reduced, gave an iron containing sulphur. Experiments were then made by dissolving the crystalline oxide in pure hydrochloric acid and precipitating the solution by ammonia, washing the oxide, and reducing it. The iron thus prepared contained sulphur. The next experiments were made by dissolving the crystalline oxide in hydrochloric acid, digesting with chloride of barium for several days, decanting and filtering through paper (previously digested with dilute nitric acid), precipitating by ammonia (distilled from ammonia to which chloride of barium had been added), washing, and reducing the oxide. The iron thus prepared still contained sulphur.

The third series of experiments were made with sublimed proto- or sesqui-chloride of iron, by dissolving it in water, precipitating with pure ammonia, washing, and reducing in hydrogen. All the specimens thus prepared contained sulphur. The sublimed chloride was obtained sometimes from the red oxide, prepared by heating the oxalate of iron obtained as above described, or from the crystalline oxide by dissolving it in hydrochloric acid, digesting with chloride of barium, evaporating to dryness, and subliming either in platinum vessels or in porcelain tubes, or in clay retorts, either alone or in a current of chlorine or of hydrochloric acid.

In the fourth series of experiments, the metal produced by either of the above methods was submitted in the platinum tube, whilst red hot, alternatively to the influence of hydrogen and oxygen or hydrogen and steam, or of vapours of nitric acid and hydrogen, or of ammonia vapours, oxygen, and hydrogen. In all the cases the operation was repeated several times, and although sulphuretted hydrogen was given off during these operations, yet the iron always contained sulphur.

Further experiments were made by dissolving the purest iron in dilute acetic acid, and evaporating to dryness, and heating. The metal obtained still contained sulphur.

Also the iron obtained from ferrocyanide of potassium* was found to contain sulphur.

In fact we have never made or found a specimen of iron which did not contain sulphur. Even electrolytic iron, said to be prepared from chloride of iron, evolved, by dissolving in dilute hydrochloric acid, a very appreciable quantity of sulphuretted hydrogen.

On the whole, we have made upwards of seventy series of experiments.

From the above it will be seen that we have not yet obtained a method of preparing iron free from sulphur. In fact, one great difficulty is to obtain vessels which will not give up sulphur to the iron in some form or another; for instance, the platinum tube had to be polished and boiled out with acid every time before use. It may be mentioned that the hydrogen employed was led through the platinum tube before reducing the oxide of iron for a quarter of an hour or more, and yielded no sulphuretted hydrogen.

Although no positive results have been obtained, we have in no ways lost hope of preparing iron free from sulphur. No doubt on a very small scale this might be done without much trouble; but we must bear in mind that our method must be such a one as to allow the reduction of pure iron on the ounce scale.

A GENERAL OUTLINE OF A NEW SYSTEM OF CHEMICAL PHILOSOPHY.*

BY DR. OTTO RICHTER.

(Abstract by the Author.)

To this paper the author proceeds upon the hypothesis that the chemical elements consist not of individual atoms, but of entire groups of such atoms or molecules. The various kinds of molecules agree in being each or all built up of precisely the same number of atoms, which are symmetrically disposed with reference to the three axes of space according to the same fundamental plan of arrangement. The constituent atoms of these molecules are each or all endowed with the same three fundamental properties of gravity, original elasticity, and electrical energy, and these properties vary in range and intensity with each species. In harmony with the common practice, the chemical elements are divided into the two principal classes of the metals and the non-metals, represented respectively by the general formula M_n and N_n . The constituent atoms are further supposed to be in a perpetual state of vibration, in which they perform a series of periodical contractions and expansions, and thus in their final effect establish between contiguous molecules a permanent tendency to repulsion, the result of which is the formation of a certain space round the centre of each molecule, which constitutes its specific volume, and is always directly proportional to the number of atoms set in motion. The volume-equivalents represent the maximum specific volumes which the elementary molecules are capable of realising; and the peculiar force, under the influence of which the vibratory movements of the atoms may *ad libitum* be arrested or restored, is called the paralytic force. The order in which this force performs its operations materially depends upon the particular portions which the various constituents occupy in the system relatively to each other. This law of Rankurder is indicated in the table of chemical equivalents in so far as any chemical element which there stands to the left or to the right of any other is supposed to occupy, in a certain sense, a similar position in comparison with any others with which it happens to be associated as a constituent member of the same type. The science of chemistry is divided into the two parts—Pondo-chemistry and Impondo-chemistry. The former treats exclusively of the molecular arrangement of the constituents; the latter exclusively of their specific volumes. Pondo-chemistry is divided into the

* Crystallised out of a solution containing chloride of barium.

* British Association, Norwich Meeting, Section B.

two principal sections of meta-chemistry, which is subject to the dominions of the principles of polarity, and includes eleven distinct types; and of para-chemistry, which is subject to the dominion of the principle of parity, and includes three types or forms of molecular grouping. After giving a general description of these various types, the author discusses the law of volume-harmony, according to which the specific volumes of constituent members of a given volume-harmonious molecule are always reducible to some simple ratio contained in the volume-harmonious scale— $1 : m \times 1$; $1 : m \times 2$; $2 : m \times 3$; $3 : m \times 4$; $4 : m \times 5$; $5 : m \times 6$; $6 : m \times 7$ —where m represents some integral number. The volume-harmonious molecules are divided into two classes. The first class comprises all those compounds where the water of crystallisation is excluded; in the second class all those compounds where the water of crystallisation is present. As regards the latter class, it is a characteristic peculiarity that in the process of reduction the saline molecule, with every fresh addition of one molecule of water of crystallisation, experiences a loss in volume amounting always to a constant quantity. This quantity remains unaltered so long as this loss in volume is caused by the successive paralysation of its envelope molecules; but when this process of reduction extends to the molecules of the nucleus, the constant quantity in some cases continues the same, but in general it merges into another constant quantity. As regards further details we must refer the reader to the original, which is now in the course of being published.

ON SOLID AND LIQUID FATS.

BY HORACE DOBELL, M.D., &c.,

SENIOR PHYSICIAN TO THE ROYAL HOSPITAL FOR DISEASES OF THE CHEST, &c.

The hypotheses which I published in the *British Medical Journal* for January, 1866, involving the suggestion that an important distinction is to be drawn between the physiological properties of solid and liquid fats, as constituents of the animal body, and as ingredients of food and medicine, has called forth many criticisms, and I have been frequently challenged to produce more detailed grounds for my opinions.

I should have published the desired details but for the deficiency of some important links in the evidence, which I have been among the first to admit and very anxious to supply. It must be observed, however, that I have never myself claimed for my views on this subject a higher rank than that of hypothesis, and I refrain from doing so until the missing links necessary to a complete theory shall have been supplied.

My object in now bringing the subject before the readers of the *CHEMICAL NEWS* is to ask for assistance in certain chemical investigations necessary to the settlement of some of the questions at issue.

So far as I am able to learn, after a very careful investigation, there is a singular absence of precise knowledge as to the relative properties of solid and liquid fats, except in regard to their saponification, and, at the same time, a remarkable want of appreciation of the probable importance of the subject; the result of which is a corresponding disinclination on the part of scientific chemists and physiologists to enter upon the necessary experiments.

A good chemist, with the command of a laboratory, and an acquaintance with the manipulation of fats, is essential to the enquiry; and I have not, up to the

present time, succeeded in finding such a person with time at his disposal willing to engage in the necessary experiments, while my own professional occupations preclude me from entering upon them without such assistance. I hope that this paper may discover some one, qualified and willing either to join with me or to prosecute the experiments single handed. In either case, I shall be happy to give him all the assistance in my power.

The most usual objections to my views, as to the importance of distinguishing between solid and liquid fats, with which I have met among medical men, have been based upon the similarity in the chemical formulæ for stearin, margarin, palmitin, and olein. Such objections will of course have little weight with those acquainted with isomerism; on the contrary, it appears to me that the peculiar isomeric modifications of which stearin and palmitin are susceptible, as shown by Duffy, pointedly distinguish them from olein, which, so far as at present known, has not this susceptibility, a distinction which is supported by the different behaviour of oleic acid towards chlorine and bromine, from that of stearic or margaric acids (Lefort), and by the different action of bile upon stearic acid and upon oleic acid (Marcet).

But I think we ought to be prepared to learn that solid and liquid fats differ in some important physiological properties by the first general fact concerning the constitution of all natural fats—viz., that they are mixtures in varying proportions of at least four different bodies, of which the melting points so widely differ—stearin melting at 144° F., palmitin at 114.8° F., margarin (probably a compound of stearin and palmitin) at 116° F., while olein remains fluid at 32° F.

That the different degrees of solidity of fats depend upon the proportions in which the solid ingredients are mixed with olein, that olein has a peculiar power of dissolving the solid ingredients, and that the melting point of the mixture is thereby reduced, appear to me to be facts pointing in the same direction as the foregoing, especially when we remember that the affinity of oleic acid for oxygen is much greater than that of the other fatty acids.

The fatty bodies obtained from warm-blooded animals are generally solid at ordinary temperatures, whilst those from fish and from cold-blooded animals are liquid. And when we consider the high melting points of the solid fats as compared with the temperature of the body in warm-blooded animals, it is evident that the fat in them would be solid at the temperature of their blood, but for the mixture of olein, by which the melting point is reduced. Therefore the solidity or fluidity of the fat in living animals is determined by the proportion of olein, which is able to be mixed with the stearin, palmitin, and margarin in each individual; and we are forced to conclude, either that it is of no importance whether the fats of the body during life are in a solid or liquid state, or that it is important in what proportion the olein, stearin, &c., shall be combined.

It has been already proved, by experiments on the fattening of cattle, that the solidity or fluidity of the fat in the body varies with the food—that cattle fattened upon linseed cake, for example, accumulate, in their adipose tissue, an oily material of unusual fluidity (Draper), and that the consistence of butter is dependent upon the kind of food given to the animals from which it is produced (Fownes).

The fat in animals is particularly liable to accumulate immediately beneath the cutis, in the omentum, and around the kidneys; and the fat found in the latter situa-

tion, where it is subject to a more uniformly elevated temperature than in the integument, is well known to be of a more suety character—that is to say, it contains a smaller proportion of olein, and has a higher melting point. These familiar facts point again to some importance in the animal economy, attaching to the melting point of the fat and the consequent degree of fluidity in which it should exist during life.

With regard to the fat of the integument—the principal deposit of adipose tissue in the body—it appears to me self-evident that the fluidity of this fat must vary with the temperature of the atmosphere in which the animal is placed; to what extent this is the case, is, in my opinion, a most important subject for enquiry, and although the experiments to determine the question are yet deficient, I hope soon to be able to supply them.

In conclusion, what I now suggest as a general proposition, is this:—That, in all probability, the stability of the fats of the animal body in resisting too rapid oxidation is dependent upon the degree of solidity which they possess at the temperature of the living animal at any given time; that alterations in external temperature may affect the solidity of the adipose tissue of the integument, and, consequently, its power of resisting oxidation; and that, therefore, in all probability, it is of great importance that the food of an animal shall contain a certain proportion of material capable of supplying the adipose tissue with solid fat.

The principal questions which I wish to submit to chemists, as requiring to be settled by their experiments, are the following:—

1. What is the relative facility for oxidation of the solid and liquid fats at similar and at different temperatures?
2. Is the facility for oxidation inversely as the melting points?
3. Is it the same for all fats at their melting points?
4. After the melting point of a fat has been attained, is the facility for oxidation affected by further increments of temperature?
5. Is there a temperature at which fats cease to be oxidisable, and if so, what relation does this bear to the melting point in each instance?

84, Harley Street, Aug. 19, 1868.

ON THE SOURCE OF LIGHT IN LUMINOUS FLAMES.*

BY PROFESSOR FRANKLAND, F.R.S.

THE most prolific source of error amongst mankind is the unquestioning acceptance of authoritative opinion. However much we may pride ourselves upon the sifting of the explanations of things by our own enlightened judgments, it cannot be denied that the *ipse dixit* mode of settlement is still wonderfully frequent amongst us. Not only is this the case with the public in general, but even the cultivators of science are not entirely innocent of the same weakness.

The essential difference between a fact and a theory is not always appreciated with sufficient vividness. The statement that "sixteen parts by weight of oxygen unite with two parts of hydrogen to form water," is considered by many, for instance, as perfectly synonymous with the assertion that "one atom of oxygen unites with two atoms of hydrogen to form water."

The existence of an imponderable ethereal medium

filling all space is often regarded as equally certain with the presence of a gaseous envelope surrounding our globe.

The atomic theory and the hypothesis of an ethereal medium are, at present, absolutely necessary, the one to the progress of chemistry, the other to the further development of physics; but neither this circumstance nor the splendid discoveries made by their aid can establish their truth. A mathematician starting from false data is sure to arrive at a false result; but it is far otherwise with theory, for false theories can, and constantly do, conduct to true facts. Thus Columbus's counterpoise theory of the earth led to the discovery of America, although that theory was nevertheless essentially false.

The most sober worker in science cannot progress without the assistance of theory to co-ordinate his facts, and to lead him on to further research. It is here that even a false theory is invaluable, and it is only when the theory continues to be held after it has become opposed to facts that it exercises a prejudicial influence upon the progress of science. Then it hinders rather than expedites the advance of the experimenter, and ought to be at once abandoned.

In pursuing the investigation forming the subject of this discourse, the speaker had been compelled thus to abandon a theory of the source of light in luminous flames, which he, in common with others, had derived from Davy's classical researches on flame.

Our text-books answer the question, What is the source of light in a luminous gas or candle flame? in the most positive and unanimous manner.

Selecting from some of the most celebrated, the following quotations may be made:—

"All our artificial lights depend upon the ignition of solid matter, in the intense heat developed by the chemical changes attendant on combustion."—*W. A. Miller.*

"Whenever hydrocarbons are imperfectly burnt, there is a deposition of carbon, and this temporary deposition of carbon is an essential condition for the production of the white light required in an ordinary flame."—*Williamson.*

"The illuminating power of the gas flame is therefore due to these carbon particles, which are afterwards burned nearer the border of the flame."—*Balfour Stewart.*

"The brightness or illuminating power of flame depends not only on the degree of heat, but likewise on the presence or absence of solid particles which may act as radiant points. A flame containing no such particles emits but a feeble light, even if its temperature is the highest possible."—*Watts.*

The speaker then proceeded to investigate a number of different flames: he showed that there are many flames possessing a high degree of luminosity which cannot possibly contain solid particles. Thus the flame of metallic arsenic burning in oxygen emits a remarkably intense white light; and as metallic arsenic volatilises at 180° C., and its product of combustion, arsenious anhydride, at 218° C., whilst the temperature of incandescence in solids is at least 500° C., it is obviously impossible here to assume the presence of ignited solid particles in the flame. Again, if carbonic disulphide vapour be made to burn in oxygen, or oxygen in carbonic disulphide vapour an almost insupportably brilliant light is the result; now fuliginous matter is never present in any part of this flame, and the boiling point of sulphur (440° C.) is below the temperature of incandescence, so that the assumption of solid particles in the flame is here also inadmissible. If the last experiment

* A Lecture delivered before the Royal Institution of Great Britain, Friday, June 12, 1868.

be varied by the substitution of nitric oxide gas for oxygen, the result is still the same; and the dazzling light produced by the combustion of these compounds is also so rich in the more refrangible rays that it has been employed in taking instantaneous photographs, and for exhibiting the phenomena of fluorescence. Lastly, amongst the chemical reactions celebrated for the production of dazzling light, there are few which surpass the active combustion of phosphorus in oxygen. Now phosphoric anhydride, the product of this combustion, is volatile at a red heat,* and it is therefore manifestly impossible that this substance should exist in the solid form at the temperature of the phosphorus flame, which far transcends the melting point of platinum.

For these reasons, and for others which the speaker had stated in a course of lectures on "Coal Gas," delivered in March, 1867, and printed in the *Journal of Gas Lighting*, he considered that incandescent particles of carbon are not the source of light in gas and candle flames, but that the luminosity of these flames is due to radiations from dense but transparent hydrocarbon vapours. As a further generalisation from the above-mentioned experiments, he was led to the conclusion that dense gases and vapours become luminous at much lower temperatures than æriform fluids of comparatively low specific gravity; and that this result is to a great extent, if not altogether, independent of the nature of the gas or vapour, inasmuch as he found that gases of low density, which are not luminous at a given temperature when burnt under common atmospheric pressure, become so when they are simultaneously compressed. Thus mixtures of hydrogen and carbonic oxide with oxygen emit but little light when they are burnt or exploded in free air, but exhibit intense luminosity when exploded in closed glass vessels, so as to prevent their expansion at the moment of combustion.

In a communication just made to the Royal Society the speaker had described the extension of these experiments to the combustion of jets of hydrogen and carbonic oxide in oxygen under a pressure gradually increasing to twenty atmospheres. These experiments, which were conducted in the laboratory of the Royal Institution, were made in a strong wrought-iron vessel furnished with a thick glass plate of sufficient size to permit of the optical examination of the flame. The appearance of a jet of hydrogen burning in oxygen under the ordinary atmospheric pressure was exhibited. On increasing the pressure to two atmospheres, the previously feeble luminosity was shown to be very markedly augmented, whilst at ten atmospheres' pressure, the light emitted by a jet about one inch long was amply sufficient to enable the observer to read a newspaper at a distance of two feet from the flame, and this without any reflecting surface behind the flame. Examined by the spectroscopic, the spectrum of this flame is bright and perfectly continuous from red to violet.

With a higher initial luminosity, the flame of carbonic oxide in oxygen becomes much more luminous at a pressure of ten atmospheres than a flame of hydrogen of the same size and burning under the same pressure. The spectrum of carbonic oxide burning in oxygen

under a pressure of fourteen atmospheres is very brilliant and perfectly continuous.

If it be true that dense gases emit more light than rare ones when ignited, the passage of the electric spark through different gases ought to produce an amount of light varying with the density of the gas; and the speaker showed that electric sparks passed as nearly as possible, under similar conditions, through hydrogen, oxygen, chlorine, and sulphurous anhydride, emit light, the intensity of which is very slight in the case of hydrogen, considerable in that of oxygen, and very great in the case of chlorine and sulphurous anhydride. On passing a stream of induction sparks through the gas standing over liquefied sulphurous anhydride in a strong tube at the ordinary temperature, when a pressure of about three atmospheres was exerted by the gas, a very brilliant light was obtained. A stream of induction sparks was passed through air confined in a glass tube connected with a condensing syringe, and the pressure of the air being then augmented to two or three atmospheres, a very marked increase in the luminosity of the sparks was observed, whilst on allowing the condensed air to escape, the same phenomena were observed in the reverse order.

Way's mercurial light was also exhibited as an instance of intense light produced by the ignition of the heavy vapour of mercury.

The gases and vapours just mentioned have the following relative densities:—

Hydrogen.....	1
Air.....	14.5
Oxygen.....	16
Sulphurous anhydride.....	32
Chlorine.....	35.5
Mercury.....	100
Phosphoric anhydride.....	71 or 142

The feeble light emitted by phosphorus when burning in chlorine seems, at first sight, to be an exception to the law just indicated, for the density of the product of combustion (phosphorous trichloride) 68.7 would lead us to anticipate the evolution of considerable light. But it must be borne in mind that the luminosity of a flame depends also upon its temperature, and it can be shown that the temperature in this case is probably greatly inferior to that produced by the combustion of phosphorus in oxygen. We have not all the necessary data for calculating the temperature of these flames, but, according to Andrews, phosphorus burnt in oxygen gives 5,747 heat units, which, divided by the weight of the product from one grain of phosphorus, gives 2,500 units. When phosphorus burns in chlorine, it gives only, according to the same authority, 2,085 heat units, which, divided as before by the weight of the product, gives 470 units. It is therefore evident that the temperature in the latter case must be greatly below that produced in the former, unless the specific heat of phosphoric anhydride be enormously higher than that of phosphorous trichloride. The speaker had, in fact, found that if the temperature of the flame of phosphorus, burning in chlorine, be raised about 500° C. by previously heating both elements to that extent, the flame emitted a brilliant white light.

To return to ordinary luminous flames, the argument of the necessity of solid particles to explain their luminosity obviously falls to the ground; and a closer examination into the evidence of the existence of these particles reveals its extreme weakness. Soot from a gas flame is not elementary carbon, it always contains

* Davy mentions this fact in connection with his view of the source of luminosity in flames, and endeavours to explain the, to him, anomalous phenomenon. He says:—"Since this paper has been written, I have found that phosphoric acid volatilises slowly at a strong red heat, but under moderate pressure it bears a white heat; and in a flame so intense as that of phosphorus, the elastic force must produce the effect of compression."—*Davy's Works*, vol. vi, p. 48.

hydrogen. The perfect transparency of the luminous portion of flame also tends to negative the idea of the presence in it of solid particles. The continuous spectrum of gas and candle flames does not require, as is commonly supposed, the assumption of solid particles. The spectra of the flames of carbonic oxide in the air, of carbonic disulphide, arsenic, and phosphorus in oxygen, are continuous, and so, as we have seen, is that of hydrogen burning in oxygen under a pressure of ten atmospheres. It is to the behaviour of hydrocarbons under the influence of heat that we must look for the source of luminosity in a gas flame. These gradually lose hydrogen, whilst their carbon atoms coalesce to form compounds of greater complexity, and consequently of greater vapour density. Thus marsh-gas (CH_4) becomes acetylene (C_2H_2), and the density increases from 8 to 13. Again, olefiant gas (C_2H_4) forms naphthaline (C_{10}H_8), when the vapour density augments from 14 to 64. These are some of the dense hydrocarbons which are known to exist in a gas flame, but there are doubtless others still more dense; pitch, for instance, must consist of the condensed vapours of such heavy hydrocarbons, for it distils over from the retorts in the process of gas-making. Candle flames are similarly constituted. The direct dependence of the luminosity of gas and candle flames upon atmospheric pressure, also strongly confirms the view that the light of these flames is due to incandescent dense vapours.

This inquiry cannot be confirmed to terrestrial objects. Science seeks alike for law in the meanest and grandest objects of creation. From questioning a candle she addresses herself to suns, stars, nebulae, and comets; the same considerations which have just been applied to gas and candle flames are equally pertinent to these great cosmical sources of light.

ON

THE ABSORPTION OF GASES BY CHARCOAL.*

BY DR. R. ANGUS SMITH, F.R.S.

DR. ANGUS SMITH, without reading a paper, said that he had somewhat farther extended his inquiries into the laws of absorption of gases, as shown by charcoal. He had some years ago said that he believed the actions were on the border between chemistry and physics, or that physical phenomena were an extension of the chemical. Last year, in a short note, he said that the gases which he tried were absorbed in whole volumes, or volumes which were multiples of hydrogen. He had now tried other gases, with the following results:—Hydrogen, 1; oxygen, 7.99; carbonic oxide, 6.03; carbonic acid, 22.05; marsh gas, 10.01; nitrous oxide, 12.90; sulphurous acid, 36.95; common air, 40.063. Nitrogen was found to be 4.27; probably this is a little too low, as there is always some nitrogen left in the heated charcoal. These numbers are got by dividing the number of volumes absorbed by each gas by the volumes of hydrogen absorbed. They are an average of many. The numbers, in some cases, differ considerably; it is supposed that the reason lies in the constitution of the charcoal, but some of it may lie in the mode of working. It seemed to him important to bring under some form of order those long observed but irregular actions which seemed little capable of being shown to be guided by a law; what that law is he did not see fully, but there distinctly was order.

* British Association, Norwich Meeting, Section B.

He considered that the ultimate particles of gas rested as strata or layers in the charcoal; the nearer particles were, therefore, less forcibly held than the more distant. They were also most difficult to remove. If this physical action had an analogy with chemical action, it would also partially throw light upon it, and it seemed to point to compounds containing parts held together more or less loosely than other parts. The gas and charcoal form such a compound already in a sense not purely chemical.

The numbers, however, require analysis and careful thought. Two of them seem very remarkable—namely, oxygen and carbonic acid, as the volumes are exactly those of the weights of oxygen in water and an atom of carbonic acid. Eight volumes of oxygen are 128 times heavier than one volume of hydrogen; the gases, therefore, do not seem to be taken up according to their atomic weights. By attention to this, he hoped that some light would be thrown on the atomic physical constitution of bodies.

In a practical point of view, he hoped to gain by the enquiry some knowledge of the phenomena of spontaneous combustion to which several substances are subjected.

Experiments on the absorption of mixed gases had been made, but were left for description when the paper was written, and also those on the extrusion of the gas by another.

He had a very long time ago illustrated the oxidising power of porous substances in reports to the British Association, perhaps so long ago that some persons thought it needful to do it again. No one, however, had succeeded so thoroughly as Dr. Stenhouse in this department.

Experiments on salts were not sufficiently telling, and a better mode of making them required to be found; but it was clear to him that the charcoal took up most readily those oxides the metals of which were less inclined to oxidise. The combinations being weaker, the bases were removed from the acid, a struggle against chemical action existing. In other words, an action with little chemical character opposed itself to the purely chemical, and by aid of mass gained something, a phenomenon which is frequent whenever chemical action is weak, and one which interferes much with exactness in analysis.

RESEARCHES ON THE ETHERS.*

BY J. ALFRED WANKLYN,

PROFESSOR OF CHEMISTRY IN THE LONDON INSTITUTION.

FIVE cubic centimetres of good acetate of ethyl and 0.3 gramme of sodium were sealed up in a small glass tube, and then heated in the water-bath to 100° C. until all the sodium had disappeared. The tube was then opened under water, and the gas which escaped measured 25 c.c. at the ordinary temperature of the air. Corrected at 0° C. and 760 m.m. pressure (dry), the volume of the escaped gas is about 23 c.c. If the volume of hydrogen which is equivalent to 0.3 gramme of sodium be calculated, it will be found to be about 140 c.c.

Therefore, this experiment establishes the fact that there is no evolution of hydrogen as a main product of the action of sodium on acetic ether. Moreover, the 23 c.c. of gas which escaped must be regarded as due

* British Association, Norwich Meeting, Section B. Communicated by the Author.

to traces of alcohol in the acetic ether, and not as arising from minor secondary reactions on the acetic ether. About 2 per cent of alcohol present in the acetic ether (and such a quantity was very probably there) is sufficient to account for 23 c.c. of hydrogen.

Another sample of acetate of ethyl, which had been very carefully prepared, evolved no gas at all when acted on by potassium or sodium.

Acetate of Amyl and Sodium.—The acetate of amyl was very carefully deprived of all traces of amylic alcohol by being treated with glacial acetic acid and hydrochloric acid gas. After this treatment it gave correct numbers on titration. 0.6 gramme of sodium and 11 c.c. of acetate of amyl were sealed up in a small tube and heated to 100° C., until all the sodium had dissolved; the tube was then opened under water. Not a trace of gas was evolved. (Calculating the quantity of hydrogen equivalent to the 0.6 gramme of sodium it will be found to exceed 250 c.c.)

Butyrate of Ethyl and Sodium.—The ether boiled at 118.5° C., and was consequently the normal (not the iso) butyrate. On being titrated it gave very correct numbers. Thirty-seven grammes of this butyric ether, 7.5 grammes of sodium, and 40 c.c. of dry common ether—



were sealed up and heated very gently in the water-bath, and shaken up well during the progress of the reaction. The sodium dissolved without any evolution of gas. The experiment was repeated with the same result.

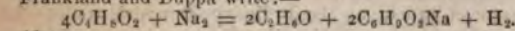
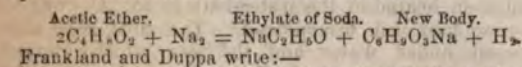
Valerianate of Ethyl and Sodium.—There is not the slightest evolution of gas when these materials act on one another.

Benzoate of Ethyl and Sodium.—Pure benzoic ether and sodium and common ether were sealed up and heated in the water-bath. There was action, but no evolution of gas.

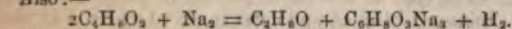
From these experiments it is abundantly evident that free hydrogen forms no part of the product of the action of sodium on the ethers of the fatty and aromatic acids.

All the modes of explaining the action of sodium on acetic ether adopted by Geuther, Frankland, and Duppa during the last few years must therefore be abandoned. The well known, and in some respects admirable, memoirs of these chemists agree in representing the action of sodium as consisting in the evolution of an equivalent of hydrogen for every equivalent of sodium consumed.

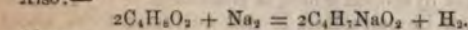
Thus Geuther writes the following equation to express the action of sodium on acetic ether:—



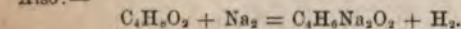
Also:—



Also:—



Also:—



All these equations affirm the evolution of as many equivalents of hydrogen as there are equivalents of sodium consumed. All of them are condemned.

In order to account for the strange error into which the eminent chemists just referred to have fallen, it will perhaps be enough to make the remark that they

appear to have omitted to measure the equivalent of hydrogen which nevertheless figures in their equations.*

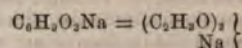
I have, on former occasions, represented the action of sodium on valerianic ether as consisting in the replacement of the acid-forming radical by sodium and the generation of free valeryl or sodium-valeryl, according to circumstances. A mode of representation of this kind will have to be adopted by chemists for the explanation of the reaction between sodium and acetic ether.

Geuther, Frankland, and Duppa agree (in this instance the agreement rests on an experimental basis) in representing a body having the formula $\text{C}_6\text{H}_5\text{O}_2\text{Na}$ as a product of the action of sodium on acetic ether. Geuther obtained and analysed it, and also the hydrogen, ethyl, and methyl derivatives of it. He also prepared some derivatives containing various heavy metals, and he investigated quantitatively a very interesting decomposition in which water plays a part, and in which acetone, alcohol, and carbonic acid are produced.

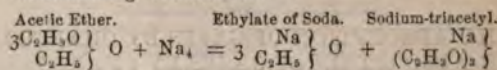
Frankland and Duppa have prepared the ethyl derivative. Altogether it is well made out that $\text{C}_6\text{H}_5\text{O}_2\text{Na}$ is produced, and that it is the main, if not the only, new compound directly resulting from the action of sodium on acetic ether.

Very complicated names have been given to it, viz., "Anthylen-di-methylencarbonsaure Natron," by Geuther, and "Ethylic-sodacetone-carbonate," by Frankland and Duppa.

On making an inspection of the formula it will be seen that it is equal to three equivalents of acetyl and one of sodium:—



and its production from acetic ether and sodium admits of the following formulation:—



No other equation is capable of rendering a rational account of the production of $\text{C}_6\text{H}_5\text{O}_2\text{Na}$ from acetic ether and sodium without necessitating the assumption that there is evolution of hydrogen.

This equation affirms that 3 equivalents of ethylate of soda are complementary products to 1 molecule of the new compound: also that 4 equivalents of sodium are required to give 1 equivalent of sodium in the form of new salt.

The following experiments accord with these conditions: I took 2.4 gramme of sodium and dissolved it in excess of acetic ether in presence of dry common ether used as a diluent. When the reaction was over water was added, by which means, of course, ethylate of soda would be transformed into caustic soda and alcohol, more or less of the caustic alkali becoming acetate of soda by action on the excess of acetic ether. The difference between the total amount of sodium employed and the sum of the amounts of sodium found as caustic soda and as acetate of soda gives the quantity of soda

* More than twenty-four years ago Löwig and Weidmann investigated the action of potassium on acetic ether, and arrived at the result that ethylate of potash and a potash salt of a new organic acid, is the product, and that no gas is given off.—(Ann. Ch. Pharm., xxxvi., 297). In 1864 (Journal Chem. Soc., vol. II., 371), I called attention to these old researches, and confirmed the result in a general way. I showed that sodium and acetic ether might be heated in a bath, the temperature of which was 130° C., without any considerable evolution of gas of any kind. Geuther and Frankland and Duppa have contradicted a well established result without publishing any adequate experiment in opposition to it.

forming the new compound. The following is a tabular statement:—

	Grammes.
Sodium found caustic	= 1.56
" as acetate	= 0.24
" as new compound	= 0.60

Sodium employed 2.40

Ratio of sodium employed to sodium as new compound—

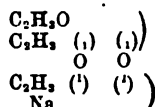
	2'40	:	0'60
or,	47	:	I

A similar experiment with potassium and without common ether as a diluent furnished an analogous result:

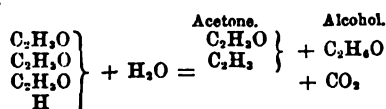
	Grammes.
Potassium found caustic	= 1.59
" as acetate	= 0.28
" as new compound	= 0.64

$$\begin{array}{l} \text{Potassium employed} = 2.51 \\ 2.51 : 0.64 :: 3.92 : 1 \end{array}$$

Sodium-tri-acetyl, $C_6H_3O_9Na$, admits of being regarded in different lights. For instance, it may be written thus: $(C_6H_3O)_3Na$, wherein the sodium is represented as being triatomic, or it may be written thus:—



wherein the three equivalents of acetyl are fused together to constitute a non-atomic tri-acetyl, $\text{C}_6\text{H}_5\text{O}_3$. Hydride of tri-acetyl, which is very well described by Geuther, is obtained by decomposing sodium tri-acetyl with glacial acetic acid, and is an oily liquid rather heavier than water; I have prepared some of it. The decomposition noticed by Geuther which it undergoes in contact with strong acids or alkalis, and in which the elements of water are taken up, is very interesting:—



The formation of alcohol in this reaction is a virtual conversion of acetic acid into alcohol, inasmuch as the tri-acetyl came from acetic acid.

All the compounds mentioned in Frankland and Duppa's paper as derived directly from acetic ether and sodium admit of representation as sodium-triacetyl, and products derived from sodium-triacetyl, as I will explain on another occasion.

ON A PECULIAR ACTION OF LIGHT UPON
THE SALTS OF SILVER.*

BY PROFESSOR MORREN.

THE molecular movements produced under the action of light present special interest, and in order to show my sympathy with this Association I present the results of some experiments, although they are at present not completed. The facts are these:—If in a tube of white glass from 14 to 15 inches long, and from 1 to 2 inches in diameter, you enclose moist chloride of silver freshly precipitated by means of a solution of chlorine in water,

and expose it to the direct action of the solar rays, it will be observed that, while the chlorine solution is still yellow, the chloride of silver remains perfectly white; but afterwards, the chlorine solution becomes colourless and clear, and the chlorine decomposes the water under the action of light. As soon as the chloride of silver blackens at the surface it should be agitated from time to time, and left exposed for a few days to direct light until the whole becomes of a fine black colour.

Now take the tube into a dark place, and you will see the blackness disappear by degrees, chloride of silver becomes reformed, and the contents of the tube become perfectly white, although its structure is evidently different to what it was previous to its exposure to light. Then we may expose it afresh to the sun, and after it has again become black we can make it white again, and this experiment can be repeated indefinitely, and is an evidence that in those successive reactions the chlorine, oxygen, hydrogen, &c., preserve their properties of combination and recombination. These gases manifest the properties which we, in France, call the nascent condition—properties certainly electric, and which only in certain circumstances become evident, but which, without doubt, exist in all bodies when the circumstances are favourable. We have plenty of examples in connection with oxygen, hydrogen, and similar bodies. There is one special and striking example in the experiment which ought to be mentioned. If we place chloride of silver in a thin and fine tube, one millimetre internal diameter, and close it at one end, this little tube being placed in the larger one, its chloride becomes dark under the action of light, but once dark it remains always black, whilst its neighbour, under the alternate action of light and darkness, blackens and bleaches, a manifest evidence of the molecular movements induced by the light upon the chloride of silver when surrounded by a suitable liquid.

It is easy to comprehend the value of the knowledge of this property in photography. We see with what care we ought to get rid of our enemy, hydrochloric acid, from our sensitive papers; to dry them perfectly, and to deprive them of all hygroscopic salts, for without doubt the image, especially the darker portions, will be liable to the decomposition and recomposition above described.

Bromide of silver presents the same properties and the same effects; but it is necessary, in order for the bromide salt to become colourless, that a longer exposure should be given. With respect to the iodide of silver, there are special conditions requisite, and I have only been able to cause this salt to blacken in the sun after having sensitised it by means of pyrogallie acid. It does not blacken visibly without a reducing agent. It would be especially interesting to know if the cyanide of silver would behave in a similar manner in the presence of cyanogen; but I have not had time to make this experiment, but I hope to be able to record it at another meeting of the Association.

THE MEASUREMENT OF GASES OVER WATER.

BY PHILIP HOLLAND.

IN an article on this subject in CHEMICAL NEWS for July 3 (*Am. Reprint, Sept., 1868, page 113*), I proposed the adoption of Erdmann's float to be used with the graduated tube when reading off a volume of gas over water. The chief advantage claimed for it is that the operator is enabled readily to appreciate differences of a tenth of a

* British Association, Norwich Meeting, Section A.

cubic centimetre when obliged to use a moderately wide tube.

At the time the article appeared I was about to leave for the Continent, and was unable to give any confirmatory experiments; I therefore take the present opportunity of supplying them. Since the use of the float requires that the measuring tube shall contain a short column of air or other gas, in order that the float may assume its equilibrium, it is scarcely necessary to add that its service is limited to the volumetric determination of those gases which do not require further treatment by reagents.

In my former communication I alluded to Dumas's method for the absolute determination of nitrogen, and singled out that gas as one to which the method then proposed could be easily applied.

In the experiments given below I have repeated, by way of illustration, one originally made by Wanklyn and Chapman, who showed, in a paper read before the Society in the early* part of the year 1866, that the hydrogen evolved by magnesium undergoing solution in dilute acid could be satisfactorily measured over water; and from the weight of the gas produced could be computed the percentage of real metal in the sample ($Mg = 12 H = 1$). The graduated tube which served me in the following experiments was divided in fractions of a cubic centimetre, the volumes and weights corresponding to the marks being determined by successive cautious additions of a volume of distilled water at 16° , the weight of which had been carefully ascertained. The calibration was conducted as follows:—Into the inverted tube was put, by means of a pipette with a long stem, sufficient distilled water to reach a division of the scale. The pipette contained about 5 cubic centimetres. I next determined the weight of the water it was capable of delivering in a given length of time. At the end of twenty seconds it was free of all water which would leave it by running; droppings were not collected. The mean of ten weighings of this volume of water at $16^{\circ} C.$, in grammes delivered in twenty seconds, was taken as the standard in the calibration. The readings were made by aid of a small telescope, the lowest level of the dark zone being considered † as the level of the water-column in the tube. The solution of the metal was effected in a small flask fitted with a caoutchouc stopper carrying a delivery-tube and small tap-funnel. The whole arrangement was filled with spring water before the evolution of gas took place, the acid being afterwards added by means of the funnel.

No. I.

Magnesium 1005 grms.
Temperature $11^{\circ} C.$
Barometer 753.4 m.m.
1st reading, corrected from table 10.43 c.c.
2nd " " " 109.31 "
Difference 98.88 c.c.
= 96.74 (dry) at $11^{\circ} C.$, 760 Bar.
= 93 " " $0^{\circ} C.$, 760 "
= 0.08333 grm. hydrogen
= per cent, 8.291
100 pts. of magnesium give 8.333 per cent.

No. II.

Magnesium 169 grm.
Temperature $11^{\circ} C.$

Barometer 751.8 m.m.

1st reading 10 c.c.

2nd " 179 "

Difference 169 c.c.

= 158.6 (dry) at $0^{\circ} C.$, and 760 Bar.

= 0.14212 grm. hydrogen

= per cent, 8.408

No. III.

The following experiments were made with commercial granulated zinc:—

Zinc 12325

Temperature $10.4^{\circ} C.$

Barometer 747 m.m.

1st reading 14.21

2nd " 58.84

Difference 44.63

= 41.72 c.c. at 0° , and 760 Bar.

= 0.03738 grm. hydrogen

= per cent, 30.32

100 pts. of zinc give 3.0769 .

No. IV.

Zinc 13575

Temperature $10.2^{\circ} C.$

Barometer 752.4

1st reading 12.3

2nd " 61.17

Difference 48.87

= 46.05 at 0° , and 760 Bar.

= 0.04126 grm. hydrogen

= per cent, 3.039 .

No. V.

Zinc 212

Temperature 11.8

Barometer 751.5

1st reading 17.1

2nd " 94.1

Difference 77 c.c.

= 71.98 at 0° at $C.$ 760 Bar.

= 0.06452 grm. hydrogen

= per cent, 3.043 .

The above experiments were not all made on the same day, as the different readings of the barometer testify. The accordance of the numbers obtained is, perhaps, as great as could be expected, when we reflect that hydrogen is not altogether insoluble in water, and, moreover, that the method adopted for calibrating the tube was not one having any special claim to precision, though its object was to afford a relation between the brass weights and the volume marks of the tube.

Chorley, Lancashire.

NOTE ON THE

DETECTION OF PHOSPHATE OF LIME IN SUBNITRATE OF BISMUTH.

BY DR. REDWOOD.

In a brief notice I gave in the last number of the *Pharmaceutical Journal* of the "Adulteration of Subnitrate of Bismuth with Phosphate of Lime," I alluded to a test recently published by Mr. Roussin. I am informed by Messrs. Howard and Sons, of Stratford, that they have found this test fallacious, as continued boiling causes a precipitate of bismuth itself when no phosphate is present. They suggest the following modification of the test, by which they say one-third of a grain of phosphate of lime is easily detected:—

"To one part of the salt of bismuth dissolved in weak nitric acid add two parts of citric acid; dissolve

* The paper appeared in the May or June number of the Chemical Society's Journal.

† A piece of thin paper should be placed behind the tube when making these observations.

with the aid of a little water; add an excess of solution of ammonia, and boil. Any phosphate present will be thrown down with continuous boiling of the solution." Although absence from home prevents my adding my own experience on the subject, I am anxious, on the unquestionable authority of Messrs. Howard, at once to guard those who may have been induced to use Mr. Roussin's test against the erroneous conclusions to which it appears it may lead. In the cases referred to in my former note, I had obtained evidence of the adulteration indicated by other and perfectly trustworthy means before my attention was directed to Mr. Roussin's test.—*Pharmaceutical Journal*.

ON FOOD.*

BY DR. LETHEBY, M.A., M.B., &C.

(Continued from *Am. Repr.*, Oct., 1863, page 194.)

Varieties of Food—their Chemical Composition and Nutritive Value.

Maize, or *Indian Corn*, is one of the most extensively used grains in the world. It enters largely into the food of the inhabitants of America, Italy, Corsica, Spain, the South of France, and the Danubian Principalities. Since the famine in Ireland, it has there also become a common article of diet, especially when potatoes are dear; but its flavour is harsh and peculiar, and nothing but a scarcity of more agreeable food reconciles people to its use. The young grain called *cob* is, however, more palatable, and forms, when boiled in milk, an American luxury which takes the place of green peas.

The farina is peculiar when examined under the microscope, and will thus serve to recognise it.

Although the meal is rich in nitrogenous matter and fat, it does not make good bread. It is, therefore, either cooked by baking it into cakes, or by stirring it into boiling water or boiling milk, as in the case of oatmeal, and thus making a sort of hasty pudding or thick porridge. This is the method of using it in Ireland, and it is flavoured with salt, or butter, or treacle. The favourite mess, called *corn-lob* by the Creoles of British Honduras, is prepared with milk in the same way. Indian meal mixed with maple sugar, and baked into cakes, formed, at one time, the chief article of diet of the almost extinct Delaware Indians.

When deprived of its gluten, and harsh flavour, by means of a weak solution of caustic soda, and then dried, it forms the expensive food called *Oswego* or *corn flour*, which is now largely used for puddings.

Lastly, it is often mixed with wheaten flour and baked into bread, but its harsh taste is never completely covered.

The grain is said to cause disease when eaten for a long time and without other meal—the symptoms being a scaly eruption upon the hands, great prostration of the vital powers, and death after a year or so, with extreme emaciation. These effects have been frequently observed among the peasants of Italy, who use the meal as their chief food, but I am not aware of any such effects having been seen in Ireland, where it is often the only article of diet.

The nutritive power of Indian meal is very high, and, considering its price, it is almost, if not altogether, the cheapest food for the poor. Calculated ac-

cording to the physiological wants of the system, a week's diet for an adult will only cost about 10½d., and excepting split peas, which are of doubtful digestibility, there is nothing approaching it for economy.

Rice is the principal food of eastern and southern nations. It is extensively cultivated in India, China, South America, and the southern countries of Europe; and it gives nourishment to not less than a hundred millions of persons. In this country, however, it is rarely employed, except as an adjunct to other foods. Now and then, in times of scarcity, it is used in the place of potatoes. Perhaps 50 per cent of our labouring classes use it in this manner. It is imported into this country in a decorticated or cleaned condition, but when it has the husk upon it, it is called *paddy*. The kinds which are most esteemed in this country are *Carolina* and *Patna*; but, according to Dr. Watson, there are many Indian varieties which are nearly equal to the American. The proportion of gluten in it is only about 6·3 per cent, and it rarely exceeds 7. It is, in fact, one of the least nitrogenous of all the cereals, and cannot be made into bread unless it is mixed with wheaten-flour, as is the custom in Paris in making the best white bread. The proportion of nitrogenous to carbonaceous matter is as 1 to 12·7, or nearly twice the amount in wheat. It is, therefore, a good adjunct to highly plastic foods, as ox-liver, poultry, veal, and fish, with all of which it goes well, especially in the savoury form of curry. Boiled with milk also, and dressed with egg, as rice pudding, it forms a substantial meal; but in no country is it eaten alone.

The *Millets*, called also *Dhurra* or *Dhoora*, are another kind of grain, and are derived from many species of plants, as *sorghum*, *penicellaria*, *panicum*, &c. Like rice, they are extensively cultivated in India, Egypt, and the interior of Africa, where they are important articles of diet. They are a little more nutritious than rice: for they contain, on an average, about 9 per cent of nitrogenous matter, with 74 of starch and sugar, 2·6 of fat, and 2·3 of mineral matter. We have no experience of their nutritive properties in this country, except in feeding birds; but in India the grains are ground whole and made into bread.

The last of the grains of any importance is *Quinoa*, a species of *chenopodium*. It is hardly known in this country, although it is extensively cultivated and consumed on the high table-lands of Chili and Peru. Mr. Johnston has described it, and he says there are two varieties of it—the sweet and bitter—both of which grow at an elevation of 13,000 feet above the level of the sea, where barley and rye refuse to ripen. It is very nutritious, and approaches oatmeal in its chemical composition, the amount of gluten being about 19 per cent, the starch and sugar 60 per cent, and the fat 5.

The next class of farinaceous foods are the *pulses*, as peas, beans, and lentils of this country, and the *dholks* and *grams* of India. They are grown and eaten in all parts of the world, and are everywhere regarded as very nutritious when they can be digested. Nothing, however, but the most prolonged cooking will serve to help in this particular. As will be seen by reference to the tables, where the composition of peas, the type of all of them, is given, they are rich in nitrogenous matter, for peas and beans contain about 23 per cent, and lentils about 25; but the carbonaceous constituents amount to only 59 per cent, or 1 to 2½. They are therefore, when eaten, invariably associated with fat. In India, the favourite pea (*cajanus Indicus*) is rubbed with oil before it is cooked. In Yucatan, and throughout the whole

* The Cantor Lectures, delivered before the Society of Arts.

of Central America, where black beans, called frijoles, are extensively used as food, they are well boiled in water, and eaten with pepper, salt, and pork. In this country, butter with peas, and fat bacon with beans, are inseparable companions. Lastly revalenta or ground lentils with cocoa, which contains over 50 per cent of fat, are mixed in a well-known fancy preparation. The nitrogenous matter of the pulses is not of the nature of gluten, but is more like casein, or the cheesy matter of milk, and it was named by Braconnot, its discoverer, legumine.

Other farinaceous foods, of little importance to us, are the meal of the *edible chesnut*, which is largely used by the peasants of Lombardy; the *Manioc* and *Lotsa meal*, which, Dr. Livingstone says, are the chief vegetable foods of the natives of some parts of South Africa; perhaps, also, the *horse-chesnut* and the *acorn* might be added to the list, for there is hope of their being easily freed from the bitter principle which now renders them useless.

And last of this class of foods are the *starches* and *arrow-roots*, which are largely imported or prepared in this country. They are Bermuda, Jamaica, or West Indian arrow-roots, from *maranta arundinacea*; East Indian arrow-root, from various species of *curcuma*; *Tousses-mois*, from *canna*; Brazilian arrow-root, from *jatropha manihot*, which, when dried and partially cooked on hot plates, makes tapioca; and which, when baked in its whole condition, forms cassava bread; sago and sago-meal from the fruit of various species of *sagus*; Tahiti arrow-root, from a *tacca*; Portland arrow-root, from the tubers of an *arum*; and English arrow-root from potatoes. All these are obtained in the same way—namely, by crushing, or bruising, or rasping the root or other substance containing them, and after diffusing through water, allowing the starch or feculoid matter to deposit; it is then collected on a cloth and dried. In this country, starches are obtained by soaking the grain in an alkaline liquor which dissolves the gluten, and then crushing between mills, straining to keep back the husk and cellulose, and then washing with water, and allowing the starch to subside. By this method of manufacture a quantity of gluten is obtained, which can be set free from the alkali by an acid and collected for food.

All the starches and arrow-roots are known by their microscopic characters, and although they have the same chemical composition and nutritive value, yet they are very different in their digestibility, for the true arrow-roots of the West Indies, as Bermuda and Jamaica, will often remain on the stomach of an invalid when the others will be rejected.

They contain no nitrogen, or but a trace of it, and therefore have no nitrogenous value, but they are useful for their carbonaceous properties; and they are best cooked by stirring them into boiling water or boiling milk, and then simmering for a minute or so.

The next class of vegetable foods are those which contain much water, and which may be called *succulent vegetable foods*, of which the potato is the most important.

Brought to us from America, in the seventeenth century, as a rarity, by Sir Walter Raleigh, it has gradually become an almost universal article of diet; for its advantages are so numerous that it will ever be a favourite food. It is, for example, easily cultivated, easily kept, easily cooked, and easily digested; besides which it requires but little flavouring matter, and never wearies the palate. It is therefore used in times of plenty

by all classes of persons, and is often eaten in quantities that approach very nearly to the rice allowance of a hungry Hindoo. "In Ireland," says Dr. Edward Smith, "when the season arrives and potatoes are plentiful, as much as 3½ lbs. are consumed three times in a day by an adult. This, indeed, is the regular allowance, and an Irishman finds no difficulty in consuming his rations of 10½ lbs. of potatoes daily." In England the farm labourer consumes, on an average, hardly as much in a week. In Anglesea, however, potatoes are eaten twice a day, and the consumption is about 16½ lbs. per adult weekly; and in Scotland the average allowance is 15 lbs. per head weekly.

The nutritive value of the potato is not great, for, in the first place, it contains only about 25 per cent of solid matter, and of this hardly 2·1 is nitrogenous. Potatoes are also deficient in fat, and therefore they require admixture with nourishing materials. They go well with meat and fish, and are considerably helped with a little dripping or butter; but the great adjunct is milk. In Ireland, potatoes and butter-milk are the principal diet, even in times of plenty.

Considering the cheapness of potatoes, halfpenny a most economical food. At the price of a halfpenny a pound, as set down in table No. 4, it costs 1·8 shillings and threepence a week to provide the carbon and nitrogen required by an adult; but when potatoes are cultivated upon cottage ground, by wife and children, as is the practice almost everywhere, as much as 7 lbs. can be easily obtained for a penny, and then the weekly diet would be rather less than eight-pence. At this price no vegetable food can compete with it.

Potatoes are best cooked in their skins, for the waste is then only about 3 per cent, or half an ounce in a pound; whereas, if they are peeled first, it is not less than 14 per cent, or from two to three ounces in a pound. The mealy varieties are more digestible than the close and waxy; in fact, when they are in this state, as is the case with new potatoes, and potatoes late in the season, which have begun to grow, they are best cooked by stewing them.

All succulent vegetables are endowed with antiscorbutic powers, but potatoes are especially renowned for this property. As far back as the year 1781, Sir Gilbert Blane, in his work on the "Diseases of the Fleet," alluded to the beneficial action of the potato in scurvy, and from that time to the present, its salutary powers had been repeatedly observed. The late Dr. Baly remarked, in his inquiries into the diseases of prisoners, that wherever potatoes were used scurvy was unknown; and it is the almost universal practice now to carry potatoes, fresh or preserved, in all ocean-going vessels, with the view of preventing scurvy.

Other succulent vegetables in common use, as turnips, parsnips, carrots, artichokes, onions, leeks, cauliflower, cabbages, and greens, have, among themselves, nearly the same nutritive value, but they are all much less nutritious than the potato, as will be seen by reference to the table No. 3; in fact, they do not contain more than from 9 to 17 per cent of solid matter, and of this only about 1·2 is nitrogenous. They are chiefly valuable for their antiscorbutic properties, and for their quality of flavouring insipid food and diluting strong ones.

Banana and bread-fruit are also valuable esculent foods, and are largely used in the tropics. The former contains about 27 per cent of solid matter, of nearly the same nutritive value as rice. About 6½ lbs. of the fresh fruit, or 2 lbs. of the dry meal, with a quarter of a pound of salt meat or fish, is a common allowance for

a labourer. The bread-fruit is largely eaten by the natives of the Indian Archipelago and of the Islands of the South Sea. There are several varieties of it which come into season at different times. It is very juicy, containing about 80 per cent of water, and is generally gathered before it is ripe, when the starch is in a mealy condition, and has not undergone change into sugar. The fresh fruit is cooked by peeling it, wrapping it in leaves, and baking it between hot stones. It then tastes like sweet bread; but much of the ripe fruit is preserved by peeling it, cutting it into slices, and packing it very closely in pits in the ground made water-tight, and lined with banana leaves. After a while it undergoes a sort of fermentation, or, as we should call it from the smell, putrefaction, and the fruit settles into a mass, of the consistence of soft cheese. When it is required for use, it is well kneaded, wrapped in leaves, and baked, like the fresh fruit, between hot stones.

Ripe fruits, as apples, pears, peaches, pine-apples, oranges, &c., are not of much nutritive value, for they rarely contain above 13 per cent of solid matter, and this is of no more value than so much rice, but they have agreeable flavours, and serve the purpose of antiscorbutic drinks.

Marine Algae.—Everywhere along our coasts, there is abundance of comparatively nutritious food, which may, by a little management, be made palatable. I allude to our sea-weeds; and this Society has distinguished itself by its efforts to utilise this stock of now almost profitless food. Judging from the analysis of Dr. Davy and Dr. Apjohn, of Dublin, it would seem that when in a moderately dry condition sea-weeds contain from 18 to 26 per cent of water; and that the nitrogenous constituents amount to from 9½ to 15 per cent, while the starchy matter and sugar average about 66 per cent. These results place sea-weeds among the most nutritious of vegetable substances; in fact, they are richer in nitrogenous matter than oatmeal or Indian corn.

The varieties of sea-weed at present used are the following:—

Porphyra laciniata and *vulgaris*, called laver in England, stoke in Ireland, and slouk in Scotland.

Chondrus crispus, called carrageen or Irish moss, and also pearl-moss.

Laminaria digitata, known as sea girdle in England, tangle in Scotland, and red-ware in the Orkneys; and *laminaria saccharina ularia esculenta*, or bladder-lock, called also hen-ware and honey-ware by the Scotch.

Ulva latissima, or green laver.—*Rhodomenia palmata*, or dulse of Scotland.—These, with many others, are eaten by the coast inhabitants of this country and the Continent. In some parts of Scotland and Ireland they form a considerable portion of the diet of the poor.

To prepare them for food, they should first be steeped in water to remove saline matter; and in some cases a little carbonate of soda added to the water will remove the bitterness. They are then stewed in water or milk until they are tender and mucilaginous; and they are best flavoured with pepper and vinegar. Under the name of marine sauce, the lavers were once a luxury in London.

As to the last of the vegetable foods—namely, the *fungi* or *mushrooms*—I have but little to say; for although the edible varieties are highly nutritious, yet they can never become an important article of diet. Most of them are employed at the present time as flavouring agents; and among these are the common mushroom for ketchup, the morel for gravies, and the truffle for turkeys and the livers of geese (*Pâté de foie gras*).

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[English Edition, Vol. XVIII., No. 458, page 126; No. 460, page 146.]

Sugar and Treacle.—Both of these are very generally consumed on account of their flavouring and fattening qualities. Dr. Edward Smith found that 98 per cent of in-door operatives partook of sugar, to the extent of 7½ ozs. per adult weekly. 96 per cent of Scotch labourers use it, and 80 per cent of Irish. In Wales, also, it is commonly used to an average extent of 6 ozs. per adult weekly; but there is a marked difference in the rate of consumption in the northern and southern portions of the country. In North Wales, for example, the average amount per head is 11½ ozs.; whereas, in South Wales it is only 3 ozs. The principal use of it is to sweeten tea.

Treacle has more flavour than sugar, and it is also cheaper. It is, therefore, more largely employed; and that description of it properly called molasses, which is the draining from the raw or unrefined sugar—treacle being the drainings from refined sugar—is preferred on account of its stronger flavour, and is most usually sold for treacle. They go well with all descriptions of farinaceous food, as porridge, pudding, dumpling and bread.

Sugar contains from 4 to 10 per cent of moisture, and treacle about 23. The rest is carbonaceous matter, without nitrogen. They are, therefore, heat-producing and fattening agents, and their power, in these respects, is about the same as with starch. Whether they can produce disease when used in excess is a matter of doubt; but Dr. Richardson declares that they cause blindness by creating opacity of the lens (*cataract*).

Animal Foods.—First on the list of these is *milk*, a liquid which contains all the elements of food required by the very young, and is therefore regarded as the type or standard of food.

In some countries, as Switzerland, it is the chief diet of the peasantry; and everywhere, if easily obtained, it is largely consumed. 76 per cent of the labouring classes of England make use of it; 83 per cent take it as buttermilk, and 53 per cent as skimmed-milk. In Wales, the average consumption of it by farm labourers is 4½ pints per adult weekly—South Wales averaging only 3 pints, while in North Wales it is 7½. In Scotland the consumption among the labouring classes is still larger, for it amounts to 6½ pints per head weekly, and in Ireland it reaches 6½ pints. Those who take least of it are the poor in-door operatives of London; the weavers of Spitalfields, for example, use only about 7·6 ozs. per head weekly, and those of Bethnal Green only a fraction above 1½ ozs. per head. When examined under the microscope, milk is found to consist of myriads of little globules of butter floating in a clear liquid. On standing for a few hours the oily particles rise to the surface and form a cream, the proportion of which is the test of quality. Cow's milk is heavier than water in the proportion of from 1,030 or 1,032 to 1,000. Asses' milk is the lightest, for its gravity is only about 1,019; then comes human milk, 1,020; and, lastly, goat and ewes' milk, which is the heaviest of all, from 1,033 to 1,042.

The quality of milk varies with the breed of the cow, the nature of its food, and the time of milking, for afternoon milk is always richer than morning, and the last drawn than the first. Taking, however, the average of a large number of samples, it may be said that cows' milk contains 14 per cent of solid matter, 4·1 of which are casein, 5·2 sugar, 3·9 butter, and 0·8 saline matter. The relations of nitrogenous to the carbonaceous is 1 to 2·2; but as fat is 2½ times more powerful than starch, the relation may be said to be as 1 to 3·6.

When milk is heated to the boiling temperature, the casein is coagulated to some extent; and if the milk has stood before it is heated, so that the cream may rise, the coagulum includes the cream, and makes the so-called Devonshire or clotted cream.

Acids also coagulate the casein, and produce a curd, as in the making of cheese and curds and whey.

Cream is rich in butter, as will be seen by reference to table No. 3. It contains 34 per cent of solid matter, 26.7 of which are butter, and its gravity is about 1.013.

Skim-milk is the milk from which the cream has been removed. It contains only about half as much butter as new milk, and its gravity is about 1.037. In all other respects it is similar to new milk.

Buttermilk is the residue of the milk of cream from which the butter has been removed by churning. It is still poorer in fat than skim-milk, containing, in fact, only about half as much. Unless it is very fresh, it is generally a little acid, and frequently the acidity has gone so far as to set the milk into a kind of jelly.

The whey of milk is the opalescent liquor from which the curd has been removed in making cheese. Although not highly nutritious, it still holds a little casein in solution, as well as the sugar and saline matter of the milk. It is rarely used as food by the poor, but is given to pigs. In Switzerland, however, it is considered to have medicinal virtues, especially for the cure of chronic disorders of the abdominal organs, and the treatment, which is somewhat fashionable, goes by the name of *curé de petit lait*. There is a popular notion that the whey of milk is sudorific, and hence we have our wine whey, cream of tartar whey, alum whey, tamarind whey, &c., when the milk has been curdled by these several substances.

Cheese is the coagulated product of milk, obtained by the addition of rennet or a little vinegar. When cream is coagulated it makes cream cheese, which will hardly bear keeping, but must be eaten fresh. It contains about half its weight of butter, and a fifth of its weight only of curd.

When cream is added to new milk, and the mixture is curdled, it forms very rich cheese, as double Gloucester and Stilton.

When new milk alone is used the cheese is less rich, but still of high quality, as Cheddar.

When an eighth or a tenth of the cream has been taken off, it produces the quality of cheese which is most sought after, as single Gloucester, Chester, American, &c.

And when all the cream has been removed, and the skim-milk is curdled, it forms the poor cheese of Holland, Friesland, Suffolk, Somersetshire, and South Wales.

At first every variety of cheese is soft and comparatively tasteless, but by keeping they undergo change, and develop their flavours, when they are said to be ripe.

Analyses of two of the most important of them are shown on table No. 3, and it will be noticed that they contain from 56 to 64 per cent of solid matter, about half of which is curd. In skim-milk cheese the curd amounts to 44.8 per cent, and the fat to only 3.6; whereas, in Cheddar, the curd is only 28.4 per cent, and the fat 31.1. In nutritive power, therefore, especially in nitrogenous matter, cheese ranks high, and is a valuable article of diet; but there is a limit to its digestibility, and hence it cannot be taken in large quantity. Considering its price also, it is hardly so profitable as many other foods; although where good skim-milk cheese

can be purchased at from 2½d. to 3d. per pound it forms, in small quantities at a time, a good adjunct to bread.

Meat.—There is hardly a class of individuals, however poor, who do not make a strong effort to obtain meat. It would seem, therefore, to be a necessary article of diet. In this metropolis the in-door operatives eat it to the extent of 14.8 ozs. per adult, weekly; 70 per cent of English farm labourers consume it, and to the extent of 16 ozs. per man weekly; 60 per cent of the Scotch; 30 of the Welsh; and 20 of the Irish. The Scotch, probably, have a larger allowance than the English, considering that braxy-mutton is the perquisite of the Scotch labourer; but the Welsh have only an average amount of 2½ ozs. per adult weekly; and the Irish allowance is still less.

It is difficult to obtain accurate returns of the quantity of meat consumed in London; but if the computation of Dr. Winter be correct, it is not less than 30½ ozs. per head weekly, or about 4½ ozs. per day for every man, woman, and child. In Paris, according to M. Armand Husson, who has carefully collected the *octroi* returns, it is rather more than 49 ozs. per head weekly, or just 7 ozs. a day. We are not, therefore, such large meat-eaters as the French.

Butchers' meat differs very much in nutritive value according to the proportions of fat and lean; and there is a strong prejudice in favour of beef as the strongest kind of meat. In reality, however, the lean of all meat is of nearly the same nutritive power, provided it is digested; but in this respect there are large differences. The flavour also varies with the nature of the animal and with its mode of feeding. Pampas-pig, and indeed most wild swine, are horribly rank, but by proper feeding they become delicious. In store animals, the proportion of lean is always greater than the fat, and the solid matter does not amount to more than 28 or 29 per cent; not so, however, in fat animals, for then the fat is largely in excess of the lean, and the solid matters make up about half the total weight. The tendency, indeed, of the fattening process is to substitute fat for water in the carcass; and the quality of the meat depends on the intimate intermixture of fat with the muscular tissue. All animals are not alike in their method of depositing fat, for some put it upon the surface of the body, and others accumulate it among the viscera. The art of breeding and feeding stock is to overcome both of these tendencies, and at the same time to produce a fat which will not melt or boil away in cooking. Oily foods have always a tendency to make soft fat.

The average proportions of fat and lean in the offal and carcasses of animals are shown in table No. VI. p. 247.

No. 3 (page 79) exhibits the proportion of the principal nutritive constituents in ordinary joints of meat. Lean meat is evidently deficient of carbonaceous matter, and this is best supplied in bread or potato; but in fat meat, considering that the nutritive power of fat is twice and a half as great as that of starch or sugar, the carbonaceous matter is often in excess of the right proportion; it is remarkably so in pork, which will bear dilution with the flesh of rabbit, poultry, and veal.

The amount of bone in meat varies: it is rarely less than 8 per cent. In the neck and brisket of beef it is about 10 per cent, and in shins and legs of beef it amounts to one-third, or even half the total weight. The most economical parts are the round and thick flank, then the brisket and sticking-piece, and lastly the leg. In the case of mutton and pork, the leg is most profitable, and then the shoulder.

TABLE VI.—PERCENTAGE PROPORTIONS AND NUTRITIVE VALUE OF THE CARCASS AND OFFAL

	IN ANIMAL.		WATER.		NITROGENOUS.		FAT.		SALTS.	
	Carcass.	Offal.	Carcass.	Offal.	Carcass.	Offal.	Carcass.	Offal.	Carcass.	Offal.
Store oxen.....	59.3	38.9	60.8	—	18.0	—	16.0	—	5.2	—
Half fat do.....	—	—	54.0	59.6	17.8	20.6	22.6	15.7	5.6	4.1
Fat do.....	59.8	38.5	45.6	52.8	15.0	17.5	34.8	26.3	4.6	3.4
Fat heifers.....	55.6	41.3	—	—	—	—	—	—	—	—
Fat calves.....	63.1	33.5	62.3	64.9	16.6	17.1	16.6	14.6	4.5	3.4
Store sheep.....	53.4	45.6	57.3	63.7	14.5	18.0	23.8	16.1	4.4	2.2
Half fat do.....	59.0	40.5	49.7	61.1	14.9	17.7	31.3	18.5	4.1	2.7
Fat do.....	—	—	39.7	55.2	11.5	16.1	45.4	26.4	3.5	2.3
Very fat do.....	64.1	35.8	33.0	45.1	9.1	16.8	55.1	34.5	2.8	3.6
Fat lambs.....	—	—	48.6	58.5	10.9	18.9	36.9	20.1	3.6	2.5
Store pigs.....	79.3	18.8	55.3	67.9	14.0	14.0	28.1	15.0	2.6	3.1
Fat do.....	83.4	16.1	38.6	59.4	10.5	14.8	49.5	22.8	1.4	3.0
Mean of all.....	64.1	34.3	48.4	53.8	13.5	17.2	34.4	21.0	3.7	3.0

Horse-flesh is hardly known in this country, except as canine food; but on the Continent, and especially in Germany, Belgium, and Switzerland, it is regularly sold in the public markets, and is considered by many persons superior to beef. Possibly we have often eaten it on the Continent without knowing it. A *châteaubriand*, or double beefsteak of Paris, is said to be best of horse-flesh; and no doubt the frequenters of the *restaurants* of Paris have unwittingly acquired a fondness for it, and have relished it as good beef. A story is told by a writer in the *Saturday Review* of a Frenchman who blandly remonstrated with an Englishman for his scorn of French beef. "I have," he said, "been two times in England, but I never find the *bif supérieur* to ours. I find it very convenient that they bring it you on little pieces of stick, for one penny, but I do not find the *bif supérieur*." "Good heavens!" cried the Englishman, red with astonishment, "you have been eating cat's-meat." To be serious, however, I do not see why the flesh of healthy horses should not be used as human food. It has, indeed, many powerful advocates, among whom is the great naturalist, Geoffroy St. Hilaire.

Venison and the dark flesh of other wild animals differs from butchers' meat in the circumstance that it is leaner, and that it contains more blood; but its nutritive power, when properly cooked, is not inferior to that of beef or mutton, and it is always more digestible.

The offal of meat constitutes about one-third of the entire weight of the slaughtered animal. It consists of the blood, the head and its contents, the tongue and brain, the heart and lungs, the abdominal viscera—as the diaphragm, the liver, spleen, pancreas, stomach, intestines, and reproductive organs, the feet, tail, and skin. In the case of the pig, the skin and head are parts of the carcass.

Nearly all these, when properly treated, are good for food. The blood of the pig is mixed with greats and fat, and converted into black-pudding, which contains about 11 per cent of nitrogenous matter. The stomach of the bullock is cleaned and boiled for tripe, which contains 13 per cent of albumen and 16 of fat. The heart, lungs, and pancreas, which constitute about 7 per cent of the live weight of animals, are as nutritious as lean meat. The head, especially of the ox, makes good soup; but it requires long boiling to extract the nutriment. Boiled for eight or nine hours it will yield one-fourth or its weight of gelatine; besides which an ox-cheek will furnish about 4 lbs. of good meat. Bones also contain much fat and nitrogenous matter, which they give up when broken small and boiled for many hours; 6 lbs. of bones are equal to 1

lb. of meat for nitrogen, and to nearly 2 lbs. of meat for carbon.

Bacon differs from fresh meat in the relatively large amount of fat and small proportion of water. It is an almost universal article of diet among the labouring classes. 74 per cent of farm servants use it to the extent of from 4 lb. to 2 lbs. per adult weekly. 69 per cent of the Scotch use it, and 40 per cent of the Irish. It is preferred to butchers' meat for many reasons—as that it goes further, especially with children, who don't generally like fat; it has more relish; it is easily cooked, and suffers less waste in cooking; besides which it is easily kept, and is always handy. Preference is nearly always given to the English bacon, notwithstanding that it is double the price of American, for the flavour is better, and it does not boil away in cooking. No doubt the inferiority of American bacon is due to the method of feeding the pigs, for they run wild and eat large quantities of acorns and oily nuts. Good bacon should not lose more than from 10 to 15 per cent in cooking.

The nutritive value of both green and dried bacon are shown in tables No. 3 and No. 4. Their peculiarity is the large amount of carbonaceous matter they contain as compared with nitrogenous. Calculated as starch, it is as 20 or 24 to 1. Hence it is that it will improve the value of substances rich in nitrogen, as eggs, veal, poultry, beans, and peas.

Poultry and the white meat of rabbits are not of themselves very nourishing. They contain too much nitrogenous matter and too little fat. In the case of aquatic birds, as the goose and duck, the fat is more abundant; but it contains certain flavouring matters which are not easy of digestion. The darker flesh of game is also somewhat indigestible, and requires management in its culinary treatment.

Fish is not a favourite article of diet with the labouring classes, unless it is salted or smoked, and then it is chiefly used for its flavouring qualities. There is a prejudice that it has no nutritive strength, and it arises, perhaps, from the circumstance that it does not easily satisfy hunger, and is quickly digested; but the inhabitants of our coasts use it largely as food.

The nutritive value of the white varieties of fish, as whiting, cod, haddock, sole, plaice, flounder, and turbot, are shown in tables No. 3 and No. 4, and it will be remarked that they contain only about 22 per cent of solid matter, 18 of which is nitrogenous. They want butter, therefore, to increase their nutritive value.

Mackerel, eels, and salmon, are, however, richer in fat, for the former contains about 7 per cent and the latter 6, while the oily matter of eels amounts to

nearly 14 per cent. The same is the case with the sprat, the herring, and the pilchard, and with most of our fresh-water fish.

All fish are in their best condition at the time of the ripening of the milt and roe, for not only are they fatter at that time, but when cooked they have a better flavour, and the flesh is solid and opaque. On the other hand, when they are out of condition the flesh is semi-gelatinous and watery.

Shell-fish of all descriptions have nearly the same nutritive values. They contain about thirteen parts of solid matter in the hundred, and this has the composition of white fish. Their digestibility varies—mussels, limpets, and whelks being rather hard of digestion, while scallops, cockles, periwinkles, lobsters, and crabs are, perhaps, a little more easily digested, and oysters still more so. None of them are suited for delicate stomachs, although the poorer inhabitants on the coast eat them freely; and vineyard snails on the Continent, and even slugs in China, have a reputation for delicacy and nutritive power.

Eggs contain about 26 per cent of solid matter, 14 of which is nitrogenous, and 10½ carbonaceous or fatty. The yolk is the part which contains the fat, for it there amounts to 31 per cent, while the white of the egg, which is entirely free from fat, is the richest in nitrogen—the albumen amounting to 20·4 per cent. Altogether, however, eggs are very deficient of carbonaceous matter, for, calculated as starch, it is only in the proportion of 1·75 to one of nitrogenous. Hence it is that eggs consort well with oil in salads, with fat bacon, and with all kinds of farinaceous matters in puddings.

Fat of some descriptions, as butter, lard, suet, or dripping, is universally consumed. In many cases it exists in sufficient quantity in the food, as in bacon and fat meat, but when this is not the case, it is invariably supplied from some other source. 99 per cent of farm labourers use fat of some sort—butter or dripping—to the extent of 5½ ozs. weekly per adult. It is difficult to say how much is really required by the human system, but looking at the proportion in milk, it would seem to be not less than 28 per cent of the dry solid food. The fats in common use contain about 80 per cent of real fatty matter, the rest being water and salt, and although butter is the fat ordinarily purchased, yet dripping is equally valuable, and so also are the vegetable fats of the tropics. Cocoa and chocolate owe their chief value as food to the fat they contain. Cocoa is composed of 50 per cent of solid fat, called cocoa butter, and chocolate is a sweet preparation of it.

Of liquid articles of diet, beer and porter stand first in nutritive value. They contain about 9 per cent of solid matter, 8½ of which are sugar and gum. Their nutritive value is not, therefore, great; and yet, according to Liebig, whenever beer and porter are not used, there is always a larger consumption of bread.

The nutritive functions of tea and coffee are hardly understood; for although they are largely used, and as if by an instinctive craving, yet their actual nourishing power is insignificant. I shall deal further with this subject hereafter.

The last constituent of food that we have to consider is saline matter. Broadly, it may be stated that we require phosphates and sulphates of potash, lime, and magnesia, and that we also want a still larger proportion of common salt. In most cases the phosphates and sulphates are in sufficient quantity in ordinary foods; in fact, Mr. Lawes found, in his experiments on the fattening of animals, that for every single part

of saline matter retained in the system of the pig, there were from fourteen to fifteen parts in the food; not that the whole of this was lost, for probably it performed important functions in the processes of assimilation and secretion. Common salt, however, is not present in the food to any large extent, and therefore it must be added to it.

And now, before leaving this part of the subject, let us pause to consider the vast machinery which is in operation for the supply of food to this metropolis. At the present time over three millions of people have to be fed daily; and yet so regular is the supply, that no one considers even the possibility of its failing. On the other hand, there is no redundancy; and not only does this supply regularly reach the metropolis, but it is distributed to our very doors. About 4,200 tons of fish; over 4,000 sheep; nearly 700 oxen; about 90 calves; 4,000 pigs, including bacon and hams; not less than 5,000 fowls, and other kinds of poultry; besides a million or so of oysters; and eggs innumerable, with flour enough to make nearly a million quarter loaves; and vegetables, butter, and beer in proportion, are daily brought to this city. "Imagine," as Archbishop Whately says, "a Head Commissioner entrusted with the office of furnishing all these things regularly to the people. How would he succeed?" And yet all this goes on with the regularity and precision of a machine, without Government or even municipal interference, but simply through the magical power and unfettered action of free-trade.

ON ACTINOMETRY.*

BY LOUIS BING.

HAVING made a few experiments for the purpose of ascertaining the actinic power of light, which I considered might not be uninteresting to science, I beg to submit the following communication to your notice:—

Permit me, in the first instance, to speak briefly of an instrument of my construction for actinometric purposes, which is already known. It consists of layers of mica, and upon each number of layers of mica is placed a figure corresponding with such number by means of an opaque pigment. This instrument, being charged with sensitive paper and exposed to the action of light, yields a graduated series of tints upon such paper, presenting white figures surrounded by darkened surfaces. The highest visible figure is always surrounded by the palest tint.

This instrument has, however, several defects, the chief of which is, that according to the varying intensities of light, its action will vary, as will be explained by the following experiment:—

You might come to the conclusion that, if the intensity of light transmitted through one layer of mica be equal to one, the intensity transmitted through two layers equal one-fourth, through three layers equal one-ninth, &c.; or that the intensities transmitted vary inversely as the squares of the numbers of layers of mica. It does, however, by no means appear that actinism is transmitted through a medium in the same harmonic progression.

From a rather thin negative print a positive firstly in the direct rays of the sun, exposing also at the same time a mica actinometer charged with sensitive standard paper to the direct rays of the sun. Examine the

* British Association, Norwich Meeting, Section A.

positive picture from time to time in a so-called photographic dark room, or in any room lighted artificially by a non-actinic light, but remove also, or screen from the light, the actinometer during the time of the examination of the positive. When you consider the positive so far printed as to be fit for photographic toning, remove the papers both from the negative and from the actinometer, and write with a pencil upon the back of the one taken from the latter the word "sun."

Next print a positive from the same negative in diffused light in the open air, exposing at the same time the actinometer, charged anew, to the same light. Pursue the same course as before, and examine your positive from time to time in the dark room, having the first positive at hand for comparison with the second. It is best to fix upon some dark, yet not black, tint in your first picture for comparison with the second; also to hold the first picture by the side of the half of the second picture which you are examining in your printing-frame. Thus make frequent comparisons with the tint you have fixed upon until the two tints appear to be alike in depth of printing. Then remove again the papers from the negative and from the actinometer, and upon the one taken from the latter write the word "shade."

Print now a third positive from the same negative inside a window where daylight is but feebly diffused, exposing again simultaneously the newly-charged actinometer by the side of the negative. Pursue again the same plan as before. After this third positive has been found to be printed equally deep as the two former, place the three papers which have been printed under the actinometer side by side for examination in your dark room.

The paper which has been printed in the direct rays of the sun will present the largest number of figures; next comes that which has been printed by diffused light in the open air, and the least number of figures will appear upon the paper printed inside the window, although the three pictures might be pronounced alike.

The positives would, however, appear not to be quite equal in tone on a more exact examination of the extreme tints in each picture with one another. The inequality would consist in this:—The positive printed in the feeblest light presents the deepest tint in the darkest shades, and the palest tints in the lightest parts. Next comes the positive which has been printed in the more bright diffused light, and the positive printed in the direct rays of the sun exhibits the least contrast between its palest and darkest tints; and its darkest tints, compared with the darkest tints in the other two positives, presents the least depth, just as its palest tint, compared with the palest tints in the other two positives, is decidedly the darkest of the three. Indeed, it does not seem possible to print three positives, in three lights of strongly-varying intensities to be exactly alike in all their tints.

If you examine now the tints, instead of the figures in the three papers printed under the actinometer, they agree with the results presented in the pictures. The first tint of the paper printed in the feeblest light, which paper shows the smallest number of figures, is the darkest. Next in order comes that which was exposed to the next brightest light; and the first tint of the paper that was exposed to the direct rays of the sun, and which exhibits the largest number of figures, is the palest on comparison with the first tints of the other two papers.

I once constructed an actinometer of only seven

figures by means of a rather opaque medium. In the direct rays of the sun the printing of a positive from a certain negative required No. 5. In a diffused light in the open air, whilst the sun was shining, a positive from the same negative required only No. 3; and printing one dull winter's day from the same negative, and under the same actinometer, the positive was finished, and not the faintest trace of a figure presented itself upon the paper taken from the actinometer. The margins of the paper projecting beyond the actinometer had arrived at the stage of strong bronzing.

This instrument would thus appear to possess but small value, both for the scientific measurement of the actinic power of light as well as for photographic purposes. It almost seems as if it had no other value but that of verifying a fact with which most photographers are familiar, namely, that in order to produce good positives from thin negatives they ought to be printed in feebly-diffused light, because the feebler light will readily act through the more transparent parts of the negative and but very slowly through the semi-opaque parts, thus yielding good contrasts between the tints of the picture; and in accordance with this fact, the feebler light acts readily through the first few layers of mica, until, after passing through a certain number of layers, it seems to possess but very slow power to affect the sensitive paper.

I hope, however, to show presently some important uses to which this instrument can be applied, and would now beg to describe another instrument of my construction.

This instrument consists of a single tube, open at one end, where light for measurement is admitted, and closed at the other. This tube is constructed of three strips of yellow non-actinic glass, and the fourth side of the tube, where sensitive paper is applied, may either consist of a strip of pure glass, with a scale marked thereon, or of a narrow scale made of metal or any other material, in which case light affects the sensitive paper quite freely.

In this state the instrument can only be used for the measurement of the actinic power of diffused light. By applying, however, a small convex mirror or a small lens at the aperture of the instrument, the direct rays of the sun can also be measured, on being received in a divergent direction within the tube. The action of light upon sensitive paper is here seen through the yellow non-actinic glass, and it can be watched without removal of the instrument or of the sensitive paper therefrom. The action of light can also at any moment be stopped, without removal of the instrument, by shutting the aperture with an opaque shutter, and thus excluding actinic light.

The principles upon which this instrument are founded are—

1st. That diffused light on entering a tube at one end only, varies in intensity within the tube inversely as the square of the distances from the aperture where light enters.

2nd. That any number of tubes, whatever their magnitude, contain the same intensity of light if the ratios of their diameters to their lengths are equal, and if we absorb the light that may be reflected from their sides.

I would now beg to call your attention to the following experiments:—

Construct a series of tubes of cardboard, open at one end and provided with a cover at the other, of the same diameter—say of two inches—and varying in length

by a semi-diameter. Let the first tube be of two inches length, the second = three inches, the third = four inches, up to ten inches, or more, if you like; but these nine tubes will suffice. The inside of the tubes must be blackened, in order to absorb the light that would otherwise be reflected from their sides.

Next construct a number of small mica-actinometers of twenty or thirty figures, and of such dimensions that they can be placed within those tubes. For the sake of convenience, let each actinometer have a letter of the alphabet whereby to name it placed upon its first layer of mica instead of figure 1. Charge each instrument with a strip of sensitive standard paper, and insert one at the base within each tube, and secure each base against the entrance of light from without. Let the actinometer named A be situated at the base of the shortest tube of 2 inches, B in that of 3 inches, C in that of 4 inches, &c., each succeeding letter in the next longer tube.

Expose now all the tubes, which are open at the ends opposite their bases, simultaneously to the same diffused daylight, five, ten, or fifteen minutes, more or less; then take all the tubes at the same time into your dark room. Withdraw the actinometers from the tubes, and the papers from the actinometer.

Please to remember now that each letter of the alphabet will be surrounded by the darkest tint upon the paper removed from the actinometer which such letter represents, because such letter is placed upon the first layer of mica, and let now each paper also be named by such letter.

On comparing the papers with one another, the following results will appear:—

1. Compare with paper A, which was printed within the shortest tube, all the other papers.

The tint around letter B = the tint around No. 3 of paper A.
 " " " C = " " " 5 "
 " " " D = " " " 7 "

Thus, through the whole series, the tint around each succeeding letter printed within the corresponding longer tube is paler by two tints.

2. Take any paper of the series, say paper D, and compare the following papers with it:—

The tint around letter E = the tint around No. 3 of paper D.
 " " " F = " " " 5 "
 " " " G = " " " 7 "
 &c., as before.

3. Compare the papers successively with one another:—

The tint around letter B = the tint around No. 3 of paper A.
 " " " C = " " " 3 " B.
 " " " D = " " " 3 " C.

each first tint equalling the third tint of the paper printed in the next preceding shorter tube.

4. Compare all the figures which each paper presents with one another. Let, for instance, paper A show twenty-five figures:—

Paper A shows 25 figures,
 Then " B " 23 "
 " C " 21 "
 " D " 19 "

each succeeding paper printed within the next succeeding longer tube exhibiting two figures less than the preceding one.

The defect which has in a former part of this memoir been shown to exist in the transmission of the actinic power of light through a medium ought to become apparent in the above experiment. On account of the comparative shortness of exposure given, it only can be traced to a small extent in the fourth comparison of the papers. This does not, however affect the general character of the experiment.

We may now draw from the above experiment the general conclusion that there is a decrease of two figures and of two tints in each succeeding paper, beginning with that which was printed within the shortest tube. Or, if the paper printed within the longest tube be represented by 1, the paper taken from the next shortest tube would equal 3, and, thus continuing, we shall have the numbers 1, 3, 5, 7, &c. On adding these figures from the beginning we produce the following series:—4, 9, 16, 25, &c., equalling the squares of the lengths of the tubes.

Without further analyses of the above experiment, I think it may be stated now that the power of actinism, as well as the intensity of light, within a tube varies inversely as the squares of the distances.

Construct next two tubes, blackened within, of different diameters, and let the length of each tube be equal to, say, twice its diameter. Let one tube have a diameter, say, of 2 inches, and the other of 6 inches; then their respective lengths must be equal to 4 inches and 12 inches.

Place at the base within each tube a mica actinometer charged with sensitive standard paper. Close each base, and expose both tubes simultaneously to the same diffused light for the same period of time. On examining the printed papers no difference whatever is exhibited in their appearance, either with regard to tint or to number of figures. You might make several such experiments, with any number of tubes of various diameters, and with the same results.

Thus the intensity of light as well as the power of actinism is the same in tubes of various magnitudes, if the ratios of their diameters to their lengths are equal.

It will be readily seen that instruments might be constructed by means of tubes of various lengths but of equal diameters, or by means of tubes varying in diameter, and of equal length, in order to produce gradations of light for actinometric purposes.

On account of its greater convenience I have, however, chosen the single square tube, and of such tube one side, as already stated.

The power of actinism and the intensity of light at any given distance on this side of the tube are, however, by no means equal to the power of actinism and the intensity of light at such given distance within the tube. But the investigation of the powers of this side light would be too lengthy for this paper.

I beg, finally, to state that, for scientific purposes, I use a tube 1 inch in width and 4 inches in length. For photographic purposes, such as the timing of photographic prints, I use a tube of half-an-inch in width by 4 inches in length.

The instrument is self-registering, and, by means of a continuous strip of paper and simple clockwork, can be made to register the actinic power of light throughout the day, per minute or per hour, or any other chosen division of time.

By combining several instruments with one clockwork, the powers of actinism during each successive minute, successive hour, and during the whole day could be registered separately.

NOTE ON THE

POSSIBILITY OF DETERMINING THE AGE OF
A SANDSTONE BY CHEMICAL ANALYSIS.

BY DR. T. L. PHIPSON, F.C.S.

A PAPER upon this subject was announced to be read by the author in Section C (Norwich Meeting of British Association for Advancement of Science, 1868), but, at his own request, it is held over till next year, in order that a greater number of analyses of sandstones may be brought forward in support of his views.

The examination of certain specimens of red sandstones belonging to different geological formations (such as old red sandstone from Hellensburg, new red from Carlisle and Withwick, near Wolverhampton, &c.), led him to believe that it may be possible to determine the particular strata to which a sandstone belongs, by ascertaining the nature and proportions of the substances which it yields to boiling hydrochloric acid.

A few analyses of various English sandstones which the author has made appear to show that:—

1. Tertiary sandstones yield to the acid principally lime and peroxide of iron.

2. New red sandstones will yield peroxide of iron, lime, and magnesia, and the latter will be found almost invariably in the proportions necessary to constitute dolomite.

3. The sandstones of the coal measures give to the hydrochloric acid a very notable amount of protoxide of iron and some manganese, as well as lime and magnesia.

4. The old red sandstones give peroxide of iron, lime, and magnesia, but the lime is in excess, and not in the proportion to form dolomite.

5. In the older sandstones, talc, or silicate of magnesia, appears, with or without the ingredients above named.

ON THE ELECTRO-DEPOSITION OF IRON.

THE following letter from M. Klein to M. Jacobi will be read with interest:—

During my stay in Paris last summer, you wished to draw my attention to the galvanic deposits of iron shown by M. Feuguères at the Exhibition; you showed me several specimens presented to you by that inventor, as well as a plate of galvanic iron produced by M. Liet as early as 1846, and presented to the *Société d'Encouragement à Paris* by M. Welter, and, although no account of his method has been published by M. Feuguères, you were desirous of encouraging me to attempt the production of reguline deposits of this refractory metal. It is well known that the attempts made from time to time in various quarters to produce galvanic deposits of iron of a certain solidity and thickness, have failed until now; nevertheless, the above-mentioned specimen of 1846, and the recent productions of M. Feuguères, seemed to me to prove the possibility of submitting this metal to the process of electro-deposition; and, with the aid of your support and enlightened counsels, I hoped, not only to arrive at similar results, but to vanquish all those obstacles generally considered as inherent to the galvanic reduction of iron.

The scientific interest offered by this new development of electro-metallurgy, and the eminent utility of its consequent application, especially to the arts of printing and engraving, led to the commencement of

my attempts in the month of October, last year, soon after my return to St. Petersburg.

The specimens which I have now the honour of submitting to your notice, consist of—1st, a tablet of iron, 150 centimetres square, and 2 millimetres thick; 2nd, of several medals; 3rd, of a medallion composed of thirty-four cameos, and 13 centimetres in diameter; 4th, of a page of moveable type stereotyped in iron, 84 centimetres square, and the block of a drawing guillochéed with the most delicate strokes, both destined for the typographic press; several prints of different colours taken from these blocks are subjoined. These specimens will serve to show the successive progressions realised since the commencement of my experiments. You will perceive that the first plate and the first medals plated by me, present, on the reverse sides, sundry porosities and deep cavities, penetrating even, in some places, the entire thickness of the deposit; however, these cavities may also be remarked in great number in the deposits of M. Feuguères. In my more recent productions these cavities, which probably proceed from bubbles of gas, have disappeared, and the reverse sides of the objects are in no way inferior to those of deposits of copper made under the most favourable conditions. In the experiments of which I now have the honour of giving you an account, my starting point was the known process of covering engraved copper plates with a coating of steel, which is quite successful in a bath composed of the chlorides of ammonium and iron, to which I added a minimum quantity of glycerin. Nevertheless, all who have attempted coating with steel must have observed, when endeavouring to give greater thickness to a very thin and brilliant layer of steel, that the surface cracks, and the deposit detaches itself from the cathode in very brittle spangles. Other baths, composed in a uniform manner, and capable of being employed under the same conditions, must therefore be used. They may be classed under two categories, comprising baths composed of sulphate of iron, and sulphate or chloride of ammonium. I first prepared three baths, according to the formula $\text{FeO}, \text{SO}_3 + \text{AmO}, \text{SO}_3 + 6\text{HO}$, differing only in the manner of their preparation. The first bath consisted of a concentrated solution of crystals of the double salt, $\text{FeO}, \text{SO}_3 + \text{AmO}, \text{SO}_3 + 6\text{HO}$, before mentioned; the second was composed of an admixture of the concentrated solutions of each of these two salts, in the proportions of their equivalents; the third bath, which distinguished itself meritoriously from the others, was obtained by taking a solution of sulphate of iron, precipitating the iron by carbonate of ammonium, and dissolving the precipitate in sulphuric acid, thus avoiding all excess of acid. For the preparation of the baths in the second category, I either mixed solutions of chloride of ammonium and sulphate of iron in the proportions of their equivalents, or I dissolved, in a solution of sulphate of iron, at a temperature of about 15° Reaumur, as much chloride of ammonium as it would take. All these baths were as highly-concentrated and as neutral as possible.

I used, for an anode, plates of sheet iron presenting a surface nearly eight times as large as that of the copper cathode. Upon the employment for decomposition of one of Daniel's cells, there were formed upon all the cathodes in the course of 24 hours, irregular deposits full of cracks, which, on the slightest attempt to remove them, broke into a thousand pieces.

As it often happens that solutions of sulphate of copper improve by use, I was in hopes that ferruginous

solutions might present some analogy in this respect; I therefore continued the experiments for some days, without, however, obtaining better results. By employing, according to your advice, instead of one cell of Daniel to each of the five decomposing troughs, four much weaker Meidinger's couples, and combining them successively with the five decomposing cells, I obtained a much slighter development of hydrogen on the cathodes, and better results. Eventually, though the appearance of the deposits still left much to be desired, especially those formed in the bath of sal ammoniac, which, from their great porosity, almost resembled sponge, those formed in the bath containing sulphate of ammonium, showed no cracks, but were formed in brilliant rays pointing upwards, and not completely covering the copper cathode. In former experiments I had observed that deposits of this nature ensued from the employment of baths accidentally containing an excess of acid; and upon examining my baths I discovered a much greater acid reaction than before. This I attributed to the fact that the quantity of iron deposited on the cathode was much greater than that dissolved from the anode. It was therefore necessary to give greater solubility to the anode, and as this result was not to be obtained by further augmentation of its surface, I conceived the idea of plunging a plate of copper into the bath, and combining it with the iron anode.

The result of this combination was most surprising; not only did the baths in the first category become re-neutralised in a few hours, but the deposits became much smoother, their colour a dull grey, and adhered perfectly to the cathode without forming bubbles, or cracking in any part. Their surfaces remained quite smooth during the first twenty-four hours, after which there began to form, in several places, the characteristic cavities, corresponding, so to speak, with those mamillary bubbles so often seen in electro-deposits of copper; these cavities, however, seldom penetrated the entire thickness of the deposit. Their production is curious, and can only be attributed to an evolution of gas on the surface of the cathode, to which it is most likely that they become so firmly attached as to prevent, in some places, the formation of the deposit. It is certain, that where the energy of the current—that is, the force of the current divided by the surface of the cathode—is too great, these vexatious phenomena occur most frequently. By reducing this energy so as to render the evolution of gas imperceptible, which I managed by either diminishing the concentration of the bath, or augmenting the resistance of the solid parts of the circuit, the formation of these bubbles entirely disappeared. Of this you may convince yourself, by examining, with a magnifying glass, the reverse side of the deposits recently obtained. It should be remarked that the baths of the second category give very good results when the anode employed is the combination of copper and iron.

I ought to apologise for entering into such minute details, but I think in these cases that an account of the failures is quite as useful as that of the successes; with your permission, therefore, I will add some further remarks on the electro-deposition of iron. It appears curious to me that the formation of the first layer of these deposits requires currents more or less strong, or baths more or less concentrated, according as to whether the cathode which is to receive the deposit be red or yellow copper, lead, type-metal, or black-leaded gutta-percha. In all cases, the formation of a smooth

deposit of iron necessitates perfect cleanliness of the surface of the cathode. Where a cathode of black-leaded gutta-percha is used, the deposit forms very slowly, and the required uniformity is often wanting; it is, therefore, preferable to cover moulds of this kind with a very thin coat of galvanic copper, and, after well rinsing in water, to transfer them direct from the copper bath into the iron bath; the thin coat of copper may be easily removed by a soft brush and a little rotten-stone.

Galvanic iron, when first taken out of the bath, is as hard as cast-steel, and very brittle, but when annealed at a temperature of dull redness, it loses much of its harshness and hardness; when further annealed to red heat, it is malleable, and may be engraved as easily as soft steel. I am happy to say that when made under favourable conditions, and annealed uniformly, and with the proper precautions, electro-deposits are not subject to twist, bend, or blister. There is no contraction, but, on the contrary, an almost imperceptible dilatation; this is of importance where the complete similarity of blocks is required, as their dimensions should receive no sensible alteration on being annealed. I propose, at some future time, to determine the specific gravity of this iron before and after annealing.

It appears that galvanic iron has no permanent magnetism, but will receive magnetism like soft steel.—(*Bulletin de la Société d'Encouragement*, xv., 288.)

HARD AND UNYIELDING CEMENTS.

BY M. SCHWARTZE.

To four or five parts of clay, thoroughly dried and pulverised, add two parts of fine iron filings free from oxide, one part of peroxide of manganese, one-half of sea salt, and one-half of borax. Mingle thoroughly and render as fine as possible, then reduce to a thick paste with the necessary quantity of water, mixing thoroughly well. It must be used immediately. After application it should be exposed to warmth, gradually increasing almost to white heat. This cement is very hard, and presents complete resistance alike to red heat and boiling water.

Another Cement.—To equal parts of sifted peroxide of manganese and well pulverised zinc white, add a sufficient quantity of commercial soluble glass to form a thin paste. This mixture, when used immediately, forms a cement quite equal in hardness and resistance to that obtained by the first method.—(*Blätter für Gewerbe*.)

ACTION OF SODIUM ON FORMIC ETHER.*

BY J. ALFRED WANKLYN,

PROFESSOR OF CHEMISTRY IN THE LONDON INSTITUTION.

PART I.

Löwig and Weidmann long ago made the very remarkable observation that carbonic oxide is evolved when sodium is placed in contact with formic ether.

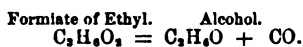
On referring to the excellent memoir of these chemists, which is to be found in the *Journal für Praktische Chemie* (1840), Band. xx., the following particulars may be read:—

Sodium placed in formiate of ethyl evolves a gas

* Original communication from the author.

which is given off from the whole body of the liquid, and not from the surface of the sodium alone. The gas was subjected to analysis by being exploded with excess of oxygen, the contraction and the carbonic acid which resulted from the combustion being measured. The numerical data thereby obtained were accurately those required by pure carbonic oxide.

It was likewise shown that there is produced alcohol and ethylate of soda. In reviewing their experiments, Löwig and Weidmann remarked that sodium seemed to exercise a kind of catalytic action on formic ether, and to induce a splitting up into carbonic oxide and alcohol.



Such, then, was the state in which the research of Löwig and Weidmann left this subject.

It will be apparent on reflection that the formation of the ethylate of soda remained to be explained, and that the existence of alcohol in presence of metallic sodium, without the occurrence of decomposition into ethylate of soda and free hydrogen, was highly remarkable.

Löwig and Weidmann also observed the formation of traces of tarry matter, but this was evidently an extremely minute by-product. They also observed formiate of soda in the ultimate product, but inasmuch as ethylate of soda will react on formic ether in presence of water in the well-known manner, so as to give alcohol and formiate of soda, the finding of formiate of soda, after treatment of the mass with water, is quite intelligible, and needs no further comment.

As has just been remarked, the difficulty was how the gas could be pure carbonic oxide, and yet that alcohol and metallic sodium should be in contact.

In recent times E. Greiner has investigated this reaction, and disposed of this difficulty in a very simple manner—viz., by denying the fact. According to E. Greiner (*Fahresbericht* for 1866, p. 300), in addition to the products described by Löwig and Weidmann, there is also free hydrogen, as a product of the action of sodium on formic ether.

I have also worked on this subject quite recently. The results of my investigation are in accordance with those of Löwig and Weidmann, and in contradiction of those of Greiner. The following experiment may be cited:—

Into a tube of about 15 c.c. capacity, closed at one end and provided with a perforated cork and bent delivery tube at the other end, there was put 2·3 grammes of formic ether, and 1185 gramme of sodium. The gas which resulted was collected over water, and after remaining in contact with it for some hours, was treated with a solution of subchloride of copper in hydrochloric acid. The gas was collected in fractions. The first fraction should contain the air originally present in the tube in which the experiment was made, and all the fractions would be necessarily slightly contaminated with air derived from the water over which they were collected.

1st fraction, 130 c.c., contained 111 c.c. of carbonic oxide and 19 c.c. of residual air, &c.

2nd fraction, 100 c.c., contained 95 c.c. of carbonic oxide and 5 c.c. of residual air, &c.

3rd fraction, 100 c.c., contained 97·5 c.c. of carbonic oxide, and 2·5 c.c. of residual air, &c.

The tube having been uncorked (by which means a little air entered), a little fresh formic ether was poured into it, and the gas collected as before:—

100 c.c. contained 92·5 c.c. of carbonic oxide and 7·5 c.c. of air, &c.

It will be seen that, allowing for the 15 c.c. of air originally included in the tube, and for the small quantities of air derived from the water of the pneumatic trough, the gas must have been pure carbonic oxide. No hydrogen, therefore, results from the action of sodium on formic ether.

In other experiments a much larger proportion of sodium was employed, and still the gas consisted of almost pure carbonic oxide.

The next point which was made the object of experimental enquiry was the quantitative relation between the sodium consumed and the carbonic oxide generated.

From 0·1185 gramme of sodium and an excess of formic ether, 420 c.c. of gas (moist) at 770 m.m. pressure and 18° C. were obtained. This equals 391·2 c.c. (dry) at 760 m.m. pressure and 0° C.; and correcting for 15° c.c. of air, equals 376·2 c.c., or 0·472 gramme of carbonic oxide.

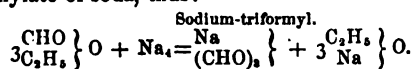
Therefore, one equivalent of sodium has liberated more than three molecules of carbonic oxide. In point of fact the action of the sodium upon formic ether belongs to the class of reactions which used to be called catalytic, a small quantity of sodium acting as it were by its mere presence, and effecting an indefinite quantity of decomposition of formic ether into alcohol and carbonic oxide.

I have also established, experimentally, that ethylate of soda alone is capable of resolving formic ether into carbonic oxide and alcohol. I dissolved a little sodium in alcohol of 96 per cent, and then added formic ether to the ethylate of soda, and warmed gently; a copious evolution of carbonic oxide took place.

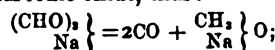
Experiments on the action of sodium on mixtures of alcohol and formic ether, have also shown that the presence of formic ether hinders the evolution of hydrogen.

From the experimental facts which have been ascertained, it is plain that there must be two stages in the action of sodium on formic ether; the first stage in which ethylate of soda is produced, and the second stage in which ethylate of soda decomposes formic ether into carbonic oxide and alcohol.

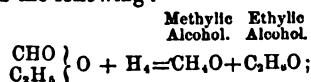
If the action of sodium on formic ether be analogous to that on acetic ether,* the first stage of the reaction ought to consist in the formation of sodium-tri-formyl and ethylate of soda, thus:—



Probably sodium-tri-formyl splits up into methylate of soda and carbonic oxide, thus:—



And probably the action of nascent hydrogen on formic ether is the following:—



but relative to this subject I expect to have experimental data shortly.

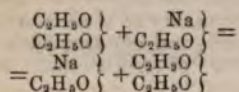
But, whatever be the exact history of the ethylate of soda (whether or not it be the complementary pro-

* See CHEMICAL NEWS, vol. xviii., p. 122.—(*Am. Repr.*, Nov. '68, page 239.)

duct to sodium-tri-formyl, as given in the above equation), there can be no doubt that the greater portion of the carbonic oxide evolved in the experiment above described owed its production to the action of ethylate of soda on formic ether.

Beilstein showed some years ago—and in 1864 I directed the attention of chemists to the importance of his observation—that ethylate of soda does not react upon the ethers of the fatty and aromatic acids, in the manner which it reacts on iodide of ethyl. With acetic ether, for instance, it forms a double compound, and does not yield any common ether and acetate of soda, whilst, as is well known, it forms common ether and iodide of sodium when it is treated with iodide of ethyl.

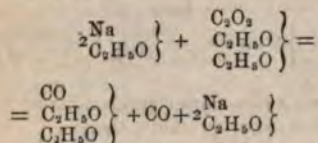
In my paper "On the Action of Sodium on Valerianate of Ethyl," published in the *Journal of the Chemical Society* for 1864, and in another paper "On the Nature of the Compound Ethers," published also about the same date, my views on this subject are developed. Acetic ether is ethylate of acetyl, and when it reacts, splits up into ethyl-oxide and acetyl. Acetic ether and ethylate of soda can only reproduce themselves by reacting on one another:—



When sodium has exchanged places with acetyl, the result is ethylate of soda and acetic ether, as at the beginning.

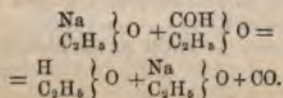
In a paper presented by me to the Chemical Society at the end of 1864, and suppressed by the Council, I pointed out that Etting's strange but well known production of carbonic ether and carbonic oxide from oxalic ether and sodium, admitted of explanation, on the principles which I enunciated at that time; and having never experimented on the subject, I predicted that ethylate of soda and oxalic ether would give carbonic oxide and carbonate of ethyl. Mr. Dittmar, who was in utter ignorance of my views on this subject, has recently verified this prediction. According to recent experiments of Mr. Dittmar's, oxalic ether is resolved by ethylate of soda into carbonic ether and carbonic oxide.

The following explanation of the change occurs in my suppressed paper:—



Sodium and oxalyl are exchangeable. Oxalyl breaks up whilst on the journey into carbonyl and carbonic oxide.

The case of ethylate of soda and formic ether is parallel with the case of ethylate of soda and oxalic ether. Formyl, on the journey, breaks up into hydrogen and carbonic oxide:—



London Institution, Sept. 21, 1868.

RESEARCHES ON ELECTRO-DEPOSITION.

BY A. BRESTER.

THE original form of this memoir was that of an inaugural treatise submitted to the faculty of sciences of the University of Utrecht, in order to obtain the degree of doctor of physic and mathematics. A large number of organic and inorganic compounds are carefully considered by the author with regard to the phenomena presented by them on subjection to the decomposing action of a galvanic current. We refer to the original work those who wish for a detailed account of the experiments, contenting ourselves here with giving a summary of the actual results of the author's labours:—

Section 1.—1st. Hydrogen evolved by the action of zinc or iron upon dilute sulphuric acid will not reduce a solution of sulphate of silver, but will reduce a solution of nitrate of silver.

2nd. It is the same with hydrogen produced by the decomposition of steam by iron rendered incandescent; it reduces the solution of the nitrate, but not that of the sulphate of silver.

3rd. Hydrogen evolved at a platinum cathode, in the electrolysis of dilute sulphuric acid, behaves in the same manner; it reduces the solution of nitrate, and not that of sulphate of silver.

4th. Hydrogen collected at a platinum cathode, when, according to Osann's direction, an aqueous solution of recently distilled sulphuric acid is subjected to electrolysis, gives rise, it is true, in a solution of sulphate of silver, to an abundant black deposit, but that deposit consists only of sulphide of silver and not of metallic silver.

5th. Hydrogen evolved in the electrolysis of dilute sulphuric acid, a charcoal cathode being used, is also incapable of reducing a solution of sulphate of silver.

6th. Hydrogen obtained by electrolysis does not differ from ordinary hydrogen in its behaviour towards silver salts.

Section 2.—A platinum cathode which, after having served to effect the electrolysis of dilute sulphuric acid, is instantly plunged into a solution of sulphate of silver, will sometimes reduce it, but more commonly fails.

Section 3.—The combination which frequently occurs between hydrogen separated by electrolysis and the negative electrode only takes place when the electrode is of platinum.

Section 4.—1st. When nitric acid does not liberate any gas at the surface of a negative electrode of charcoal or platinum, the acid is reduced to the state of ammonia.

2nd. In the electrolysis of concentrated nitric acid the same current will not absolutely disengage any gas at a platinum or charcoal cathode; although it will separate a small quantity at a cathode of iron which has been rendered passive.

Section 5.—1st. If in the electrolysis of nitric acid, an anode of platinum wire and a cathode of silver wire be used, and after bringing them just into contact in the centre of the electrolyte, then separated, the anode assumes a dark brown colour at the place touched by the cathode.

2nd. It is frequently at this point that the gaseous evolution begins, which rapidly spreads over the whole surface of the anode, generally after the disappearance of the dark brown colour.

3d. When once an anode has acquired the property of turning brown at the moment when the circuit

closed, it retains that property even if the cathode be withdrawn and replaced in the liquid five or six times consecutively.

4th. An anode of platinum wire, after being brought into contact with a cathode of silver wire, presents the same brown colour in concentrated sulphuric acid as in nitric acid.

5th. This brown colouring does not appear in red fuming nitric acid, in sulphates, nitrates, caustic potash, chlorhydric acid, phosphoric acid, and dilute sulphuric acid.

If the galvanic current be conducted through the medium of two platinum wire electrodes across red fuming nitric acid, no gas is at first disengaged at either electrode, and at the positive pole NO_2 is totally changed into NO by oxidation. At the negative pole NO_2 is reduced to NH_3 during the whole duration of electrolysis.

Section 7.—1st. Although Davy used a battery of 200 elements to liberate the potassium contained in melted caustic potash, a battery of six elements of Bunsen is capable of producing a phenomenon of light at the surface of the cathode, also due in all probability to the combustion of the potassium.

2nd. In the electrolysis of melted caustic potash, an anode of either platinum, silver, or copper, dissolves in the fused alkali, and the above named metals are deposited on the cathode.

3rd. This electrolysis is accompanied by numerous secondary phenomena.

4th. Even without electrolysis silver will dissolve in large quantities in melted caustic potash.

Section 8.—1st. The electrolysis of melted caustic soda manifests phenomena analogous to those observed in the electrolysis of melted caustic potash.

2nd. When the electrolysis of melted alkalis occurs between a cathode of platinum wire and an anode of silver wire, a coating is formed upon the cathode, composed for the most part of silver, but which leaves, upon treatment with nitric acid, a black pulverulent residue probably of platinum.

Section 9.—In the electrolysis of sulphate of soda between two platinum electrodes, sodium is liberated at the negative pole, and combines with the platinum of the cathode.

Section 10.—1st. When melted chlorate of potash is decomposed between a platinum anode and a cathode of platinum or copper, potassium is separated at the negative pole, and unites with the platinum or copper of the cathode.

2nd. In the same electrolysis a mixture of chlorine and oxygen takes place at the positive pole; the oxygen in this mixture has an odour of phosphorus, and when brought into contact with water gives rise to thick white vapours.

Section 11.—1st. When concentrated formic acid is decomposed between two platinum plates, traversed by the current of six elements of Bunsen, a mixture of two volumes of carbonic acid and one volume of oxygen separates at the positive pole.

2nd. When concentrated formic acid is decomposed by a current of the same force, but between two electrodes of platinum wire, the mixture evolved at the positive pole consists of four volumes of carbonic acid and one volume of oxygen.

3rd. In this last electrolysis, the gaseous cation takes a volume much smaller than double that of the gaseous anion.

Section 12.—1st. Accordingly as n takes a greater

value in the general formula, $\text{C}_n\text{H}_n\text{O}_n$, of fatty acids, these acids are more and more imperfect conductors of the galvanic current.

2nd. Dilute acetic acid, submitted to the action of six elements of Bunsen, evolves pure oxygen at the platinum anode.

3rd. Concentrated acetic and butyric and valeric acid will conduct feebly the current of six elements of Bunsen.

4th. Palmitic and stearic acids in the melted state isolate perfectly the current of a battery of eight elements of Bunsen.

Section 13.—1st. Benzoic acid, $\text{C}_7\text{H}_5\text{O}_2$, in a fused state will not conduct the current of eight elements of Bunsen.

2nd. When an aqueous solution of benzoic acid, saturated in the cold, is decomposed between two platinum electrodes by the current of six elements of Bunsen, oxygen is separated at the positive pole and an equivalent quantity of hydrogen at the negative pole.

3rd. It is very probable that in this same electrolysis there is no separation of benzoic anhydride at the positive pole.

4th. During this electrolysis it sometimes happens that the negative electrode of platinum wire is covered with a black coating which disappears on exposure to the light.

Section 14.—1st. In the electrolysis, by five elements of Bunsen, of a saturated aqueous solution of cinnamic acid, the gaseous cation occupies a volume exactly equal to three times that of the gaseous anion.

2nd. During this electrolysis, oxygen, carbonic acid, and crystals of cinnamic acid are separated at the platinum anode.

Section 15.—1st. In the electrolysis of dilute lactic acid by the current of six elements of Bunsen, the gaseous cation takes a volume seven times larger than that of the gaseous anion.

2nd. This gaseous anion contains one volume of carbonic acid to four volumes of oxygen.

Section 16.—1st. In the electrolysis of a saturated aqueous solution of oxalic acid by a battery of six elements of Bunsen, twice as much gas is evolved at the negative pole as at the positive.

2nd. The gaseous anion resulting from this electrolysis is composed of two volumes of carbonic acid and one of oxygen.

Section 17.—1st. In the electrolysis of a saturated aqueous solution of tartaric acid by a battery of seven elements of Bunsen, hydrogen is separated at the negative and an equivalent quantity of oxygen at the positive pole.

2nd. During this electrolysis a negative electrode of sheet platinum is sometimes covered by a black coating, not apparently soluble in any acid, but which decomposes on exposure to the light.

3rd. This coating can be nothing but hydride of platinum.

Section 18.—1st. The gaseous anion liberated by electrolysis of a combination of an inorganic base with an organic acid, commonly differs greatly from the gaseous anion separated by electrolysis of the acid forming part of that combination, and employed in an isolated condition.

2nd. In electrolysing an aqueous solution of formate of soda (density 1.197) pure carbonic acid is separated at the positive pole of a battery of six elements of Bunsen's.

3rd. During this electrolysis a light brownish red precipitate is formed upon each of the two platinum electrodes.

Section 19.—1st. In the electrolysis by the current of six elements of Bunsen of an aqueous solution of valerianate of potash, the gaseous anion is formed of—

52.91	volumes of carbonic acid.
37.37	" " butylene.
9.71	" " oxygen.

2nd. In the electrolyse of melted palmitate of soda by means of a current of five elements of Bunsen, gas is evolved at each of the platinum electrodes, and at the same time the platinum of the negative wire combines with sodium.

3rd. That which takes place in the electrolysis of melted sulphate of soda, in that of melted chlorate of potash, and in that of melted palmitate of soda, is also the same in melted sodic soap; part of the alkaline metal set at liberty at the negative pole unites with the cathode of platinum wire.

4th. Melted axunge and grease will perfectly isolate the current of a battery of ten elements of Bunsen.

Section 20.—1st. In the electrolysis by a battery of from five to eight elements of Bunsen, of a saturated neutral solution of benzoate of potash, benzoic acid and oxygen are separated at the positive, and hydrogen at the negative pole.

2nd. The volume of oxygen evolved in this electrolysis is rather less than half the bulk of hydrogen which is liberated.

3rd. After forty-eight hours' electrolysis the benzoate of potash assumes a yellowish brown colour at the positive platinum electrode.

Section 21.—1st. A saturated aqueous solution of cinnamate of soda decomposes, under the influence of the current of five elements of Bunsen, into cinnamic acid, oxygen, and hydrogen.

2nd. Part of the cinnamic acid separated in this electrolysis is transformed by the liberated oxygen into oil of bitter almonds and carbonic acid.

3rd. In the electrolysis of aqueous solutions of several acids and of the salts of these acids, it is not the anhydride of the acid which is liberated, but the acid itself.

Section 22.—1st. The gaseous anion of a concentrated aqueous solution of lactate of potash, does not nearly take half the volume of the gaseous cation; it is composed, when a current of six elements of Bunsen are used, of eighty-six volumes of carbonic acid and four volumes of oxygen.

2nd. During the electrolysis of lactate of potash, a formation occurs of aldehydic resin.

Section 23.—1st. In the electrolysis of a saturated solution of malate of potash by a current of five elements of Bunsen, the gaseous anion occupies a volume equal to $\frac{3}{5}$ ths of the volume of the gaseous cation.

2nd. 33.5 volumes of the gaseous anion are composed of thirty-two volumes of carbonic acid, and 1.5 volumes of a gas, which, on lighting, burns clearly and brilliantly.

3rd. In this electrolysis there is separated at the positive pole, in addition to malic acid, a volatile acid.

4th. The solution of malate of potash assumes, at the platinum anode during electrolysis, a light yellow colour, and at the end of eight days turns to reddish brown without new action from the current.

Section 24.—1st. *Eau sucrée* of a density of 1.13 offers

to the current of a battery of four elements of Bunsen, a degree of conductivity about thirty-nine times less than that of sulphuric acid 1.24 in density.

2nd. According as the density of the *eau sucrée* increases from 1, its conducting power first augments and afterwards decreases.

3rd. In the electrolysis of *eau sucrée* between two electrodes of platinum wire, the relation between the volume of the gaseous cation and that of the gaseous anion approaches nearer and nearer to 2, according as the intensity of the current increases.

4th. The mixture of gaseous ions does not contain carbonic acid during the first moments after the commencement of the electrolysis, but after forty-eight hours it contains 6.6 p.c.

5th. *Eau sucrée* traversed by a current of six elements of Bunsen, conducted by two electrodes of platinum wire, turns acid, acquires strong reducing properties, and is precipitated by acetate of lead.

7th. By prolonging the electrolysis of *eau sucrée* the acid at first formed, is in its turn decomposed and oxidised.

8th. When the current of seven elements of Bunsen is conducted between a cathode of platinum wire and an anode of iron wire, gas is evolved at the cathode only; while at the anode a green flaky body is separated, which in the places which come in contact with the air, decomposes into a weak acid and into hydrate of iron.

9th. A copper anode also disengages no gas in the electrolysis of *eau sucrée*, but separates an unstable greenish blue substance.

10th. A zinc anode when employed in the electrolysis of *eau sucrée* becomes covered with a flaky white substance which, when washed and dried, is found to be hydrate of oxide of zinc.

Section 25.—1st. In aqueous solutions of starch, dextrine, and gum arabic, an anode of iron wire is also covered with a green and flaky salt of protoxide of iron, whose base, influenced by the oxygen in the air, abandons the acid and changes to peroxide of iron.

2nd. As long as the green substance formed in a solution of starch remains unaltered, the solution will not reduce the test liquid of the saccharine matter; but it will perform the reduction as soon as the green substance has assumed a red colour.

3rd. A solution of starch conducting the current of six elements of Bunsen between two electrodes of platinum wire, gives a neutral reaction even after five days, and does not change into sugar.

4th. Collodion conducts the current of eight elements of Bunsen very badly; but, nevertheless, yields a small quantity of gas at the cathode when the two electrodes are brought close to one another.

5th. In this electrolysis a platinum anode is covered with a gelatinous, colourless, and transparent substance, which, on being dried and burnt, burns with rapidity and deflagration in the same manner as gun cotton.

FOREIGN SCIENCE.

PARIS, SEPT. 9TH, 1863.

The Sewage Question.—New Process for Preserving Wine.—New Researches on the Action of Dry Hypochlorous Gas on a Mixture of Iodine and Acetic Anhydride.

The attention of the readers of the CHEMICAL NEWS has already been directed to the interest in the sewage question,

manifested here. M. Verstraet, in a long article published in the journal so ably conducted by M. L'Abbé Moigno—*Les Mondes*—reviews the subject and advances some new projects. The disinfection and removal of the refuse of Paris, and its subsequent treatment in the basins of Bondy, he says, have become a question of concern with the administration of the town. Paris complains, with reason, of the emanations which taint the atmosphere from ten at night to seven in the morning; the communities situated round Bondy exclaim against the fœtid atmosphere they breathe. These inconveniences in the present state of things occur (1) from the inability of the companies charged with the collection of the refuse to perform the far too heavy obligations imposed upon them; (2) from the fact that the disinfectants employed give only incomplete results. These disinfectants are metallic salts and principally protosulphate of iron; but the simple use of these salts can only remove the sulphide and carbonate of ammonium. Considering also the question in regard to agriculture, one finds that, owing to ignorant manufacture, more than three-fourths of the original matter is excluded in the manufactured manure. Three great points ought to be borne in view in a really rational process: (1) to destroy deleterious products, or rather to make them enter into new compounds insoluble in water, these products are hydrosulphuric acid and carbonic acid or their ammoniacal salts; (2) to render inodorous and inoffensive infectious products, miasmatic emanations of organic origin; (3) to eliminate such useless products as washing water, which tends to increase every day, by reason of the adoption of certain English arrangements in all recently constructed houses. The following is the process M. Verstraet employs to attain these conditions:—

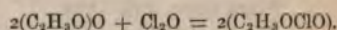
1. *Decomposition of Sulphide and Carbonate of Ammonium.*—For this purpose the chlorides are employed, either of iron, zinc, or preferably manganese. As to sulphates, at present only employed, their use is absolutely proscribed, and for the reason that the putrefying matters react on the sulphate of ammonia formed by double decomposition, the final result being the evolution of sulphuretted hydrogen, so that after a little time it is necessary to disinfect a second time. The chloride of manganese proposed as a disinfectant would be obtained from the chlorine residues of manufacturing, a product which is stated to be valueless. The residues contain too much hydrochloric acid to be immediately available; the acid is neutralized either by the oxides of iron or zinc, or by dolomite, to which preference is given. By this saturation of hydrochloric acid with lime and magnesia, the value of the product as a manure is greatly enhanced. Experiments on a large scale showed the product to be very rich in nitrogen and in phosphoric acid, and the fluid after this treatment was found to contain no phosphoric acid. Manganese, as well as magnesia, has been demonstrated by the recent works of M. Peligot to be easily assimilated by plants. To render the action of the chloride of manganese still more efficacious, 5 litres of chloride of lime solution of 12° are added to 100 litres of the manganese solution.

2. *Suppression of Odours of Organic Origin and of all Subsequent Putrefaction.*—Notwithstanding the value of the disinfectant thus prepared, it is quite certain that metallic salts by themselves can effect no complete and permanent disinfection, no influence will be exerted upon the offensive odour, *sui generis*, of the refuse matter. The antiseptic agent introduced for this purpose is tar solidified by admixture of cinders, deprived of sulphur compounds by exposure to the air for fifteen or eighteen months. In this mixture are contained a considerable quantity of sulphate of alumina, 15 or 20 per cent of finely divided carbon, 50 or 60 per cent of nitrogen and protosulphate of iron, and silica in small quantity. In the place of the solidified tar, the heavy oil of tar residues have been employed with equal success. Lastly, to clarify the water, a solution of impure sulphate of alumina, employed in the dose of a kilogramme per cubic metre, has been found to give very remarkable results; this solution

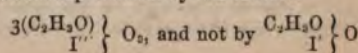
serves to clarify the liquid and to cause the deposition of the solid matter. One example of the practical results. A cess-pool of 20 cubic metres in Rue des Jeuneurs was treated with 650 kilogrammes of manganese and 30 kilogrammes of chloride of lime liquid of 9°, then 180 kilogrammes of the aluminous powder with tar. After the liquid had been agitated and allowed half-an-hour's repose, it was clear and inodorous. The sanitary inspectors and other critics who witnessed the experiment testified that the matters were completely disinfected. After the liquid had been poured off into the sewer, the atmosphere of the receptacle was tested by the lowering of a light, after which two workmen descended, who found no other odour than a slight one of benzol.

M. Dumesnil has devised a new process for preserving wine; the process is not without other than commercial interest. The cask of wine uncorked is placed under an iron bell and the air exhausted; two hours' work is necessary before the noise occasioned by the exit of the air ceases. A vacuum being created the gases contained in the wine are released from atmospheric pressure, and as they are essentially elastic, they expand sufficiently to break the cells of vegetable fibrin enclosing them, and escape. These gases are dissolved to such an extent that the withdrawal of 30 or 40 litres of gas occasions no sensible decrease of liquid. The theory of the decomposition of grape juice and other organic substances rests on a very elementary fact, viz., on the power of double decomposition. Gaseous products of the fermentation do not remain inert, but energetically induce the fermentation or decomposition of free bodies. These products are the most active in inducing decomposition; they alter wines indefinitely when enclosed in the fibrin cells, which M. Pasteur calls mycoderms. White wines owe their great superiority in preservation over red wines, to their different condition as regards this point. M. Dumesnil gives an example of the practical value of his process. He allowed the wines of 1865 to ferment till March, 1866, so as to allow of the conversion of all the sugar and extractive matter into alcohol. At this period he substituted for the usual operations the treatment by the vacuum; fermentation ceased entirely. The wines thus treated arrived at their destination in good condition; with other samples treated in the usual way the result was very different. Notwithstanding four rackings, and possibly four clarifications, the wines have continued to ferment during the whole of the year 1866 and also the commencement of 1867, and they probably still contain gases which will affect them more slowly. M. Dumesnil mentions that his wines of 1867, treated in last March by the vacuum, yielded twice as much gas as those of 1865.

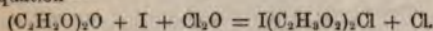
The following is an abstract of a memoir presented to the Academy a short time back, entitled "New researches on the action of dry hypochlorous gas on a mixture of iodine and acetic anhydride," by M. Schützenberger:—Former researches of M. Schützenberger showed that hypochlorous acid and acetic anhydride react upon each other to form a compound possessing the characters of an acetate, in which the metal is represented by chlorine. The reaction is in fact—



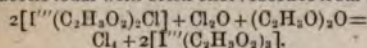
The percentage composition and the whole of the properties of this body, particularly the action of metals, which liberate chlorine in the cold, with production of a metallic acetate, leave no doubt as to the constitution of this body, acetate of chlorine. Acetate of chlorine is decomposed in the cold by iodine, with disengagement of chlorine, a solid compound being formed; curiously, the substitution of the chlorine by iodine, instead of being in the proportion of their atomic weights, takes place by the substitution of one atom of iodine for three atoms of chlorine, and the solid product has the composition represented by the formula—



The iodine acts as a triatomic element capable of fixing three atoms of oxacetyl, just as it can fix three atoms of chlorine in the trichloride of iodine, $I^{III}Cl_3$. M. Schützenberger has prepared what he terms triacetic iodal, by passing a current of dry hypochlorous acid into acetic anhydride holding iodine in suspension, cooling the mixture with water; at the end of the operation yellow needle-shaped crystals are formed, their formation preceding that of the granular compound of triacetic iodal. The first crystals are formed in abundance about the moment when all the iodine is dissolved, and when the liquid is no longer orange-tinted. When two parts of acetic anhydride are taken for one part of iodine, the liquid becomes a solid mass. The crystals are easily purified by dissolving them, with the aid of heat, in acetic anhydride (at 60°); they are deposited in long yellow needles upon cooling; great difficulty is, however, found in completely isolating them from the mother liquor in a fit state for analysis. Diaceto-chloride of iodal is produced according to the equation—



During its formation, the disappearance of the iodine and the evolution of chlorine are alone observed. An excess of hypochlorous acid in presence of acetic anhydride transforms it into triacetic iodal with brisk effervescence from chlorine—



Water decomposes it instantaneously with production of acetic acid, hydrochloric acid, iodic acid, and chloride of iodine. Heated with acetic anhydride, it is decomposed towards 100° , yielding chloride of acetyl, iodic acid, a little free iodine, carbonic acid, and acetate of methyl.

A solution of triacetic iodal in acetic anhydride is acted upon in the cold by metals, such as copper, giving an acetate and a metallic iodide. Zinc ethyl acts energetically upon triacetic iodal, acetate of zinc, acetate of ethyl, and iodide of ethyl being formed. Triacetic iodal does not act upon benzol in the cold. If the mixture be heated in presence of an excess of benzol to a temperature not exceeding the boiling point of the hydrocarbon, the iodal is dissolved at first and may crystallise upon cooling, but gradually this effect disappears, and when crystals cease to be deposited upon cooling, one finds besides the benzol, (1) a liquid boiling between 180° and 190° , possessing the properties and composition of monoiodised benzol, already obtained by the action of chloride of iodine upon benzoate of soda; (2) a solid body insoluble in water, soluble and crystallisable in alcohol. This substance has yielded 85.4 per cent of iodine; it appears to be a mixture of tetraiodised and quintiodised benzol. The decomposition at 100° of diaceto-chloride of iodal, in the presence of acetate anhydride, furnishes a rapid method of preparing iodic acid. This acid is still more easily obtained by following the method of M. Kekulé for the preparation of iodised benzols; the action is very lively and requires moderating. When sufficient iodic acid is employed, the liquid upon cooling becomes a solid mass of iodic acid, which is easily purified by dissolving in boiling benzol and crystallising.

PARIS, SEPT. 16TH, 1868.

Researches on the Bleaching of Tissues.—Electric Pyrometer.

M. KOLB has made some researches upon the bleaching of tissues. Flax was the fibre chiefly used in the experiments. A memoir presented to the Academy comprises the first portion of the results; it develops the results furnished by studying the treatment of the fibre with alkalies, and has for its object to fix precisely the nature of the substance which passes by the names of resin, gummy matter, gum-resin, saponifiable matter, &c. Elementary analysis gave no information; it gave figures which closely approached the percentage composition of cellulose. The employment of various solvents used in organic chemistry, on the contrary, led to certain conclusions by a chain of facts. The fibre after treat-

ment with alkalies, furnished strongly coloured lyes, which had a certain tendency to mould; this result suggested the idea of a saponification, and led to the examination, as solvents, of alcohol, ether, and essential oils. The yellow colouring matter is completely insoluble, and these liquids only remove from the fibre a white fatty matter and a green essence, the penetrating odour of which is found slightly perceptible in bleachers' lyes. The whole only constitutes 4.8 per cent of the weight of the fibre, and is the portion really saponifiable in caustic alkalies; the alkaline carbonates leave this fatty matter in the fibre, which becomes, at the same time, more supple. After exhaustion by alcohol, the fibre, boiled in weak potash, soda or ammonia solution, gave, in three cases, a loss in weight of 22 per cent. Carbonate of soda possesses exactly the same solvent power, but it acts more slowly. The brown lyes thus obtained, neutralised by hydrochloric acid, give a brown gelatinous precipitate; but the colouration of the liquid still indicates the incompleteness of the precipitation. Neither acid in excess, nor lime or baryta, will precipitate that which remains of the colouring matter in solution. This soluble portion varies according to the amount of alkali, and especially according to the duration of the ebullition; thus twelve hours' ebullition with ammonia suffices for acids to cause no precipitate in the solution. The fibre, treated by boiling water, loses at the end of a week 16 per cent of its weight, and 18 per cent when pressure intervenes; the matter dissolved is acid to litmus, colours the water slightly, and possesses the singular property of browning by simple contact with alkali. Considering these first characters, it is difficult to admit the presence of a resinous matter. Caustic alkalies or alkaline carbonates do not act as simple solvents, for in boiling the fibre with determinate amounts of carbonate of soda or sulphide of sodium, it was found that after eight hours' ebullition no trace of carbonic acid or hydrosulphuric acid remained. Resins do not give similar results; they saponify equally well with sulphides and alkaline oxides. Lime does not precipitate this substance dissolved by the alkalies; the fibre boiled with milk of lime loses the same weight as in soda, a soluble combination being formed with lime, containing 48 parts of this oxide for 100 of the colouring matter; chalk gives the same result, although more slowly. The treatment by chalk and lime presents this particular—that the solutions obtained remain colourless, and that the precipitates obtained are white. Analysis assigns to the substance soluble in alkalies and reprecipitated by acids, the following numbers:—Hydrogen, 5.0; carbon, 42.8; oxygen, 52.2.

The research has led to the establishment of the following facts:—The gummy substance which adheres to the fibres of flax is nothing else than pectose. The soaking or steeping of the fibre appears to have for its object the determination of the pectic fermentation, and the pectic acid which results remains fixed on the flax, either mechanically or in part in the form of pectate of ammonia. The caustic alkalies in the cold form gelatinous pectates, which preserve the fibre from being completely attacked. Pectic acid being weak, the alkaline carbonates have in the cold only a feeble action upon the fibre. Ebullition, on the contrary, transforms pectic acid into an energetic acid—metapectic acid, the carbonates are then strongly attacked, and their employment becomes as efficacious as that of caustic alkalies. The carbonate of soda, even in large quantity, is not a cause of the weakening of the fibre, which loses more strength from the employment of caustic soda, especially when the lye is concentrated. The employment of lime, even in the cold, weakens the fibre considerably. But the chief cause of the destruction of the solidity of the fibre is too prolonged digestion, particularly with caustic soda. M. Kolb says, that after having proved the existence of pectose in the unsteeped flax, and of pectic acid in the same flax after steeping, it is to be hoped that the attention of chemists will be drawn to the pectic fermentation, well known, doubtless, as a scientific fact, but of which no one suspected an industrial application of so high importance.

M. Becquerel has invented an electric pyrometer for the measurement of high temperatures. Metallurgists will probably find this application very advantageous. To solve the problem of the commercial application of a thermo-electric current as a pyrometer, it was necessary to combine a thermo-electric couple by the aid of two unalterable metals, resisting the highest temperatures, and then to establish a graduated table. As to the practical installation of the pyro-electric couple, it is easily made. A table of sines has been specially constructed for these observations.

SCHOOLS OF CHEMISTRY.

EXAMINING BOARDS.

UNIVERSITY OF LONDON.

THE University of London is not an educating body; it simply grants degrees. The Matriculation Examination includes the following subjects:—

Heat—its sources. Expansion. Thermometers—relations between different Scales in common use. Difference between Temperature and Quantity of Heat. Specific and Latent Heat. Calorimeters. Liquefaction. Ebullition. Evaporation. Conduction. Convection. Radiation.

Chemistry of the Non-Metallic Elements, including their compounds as enumerated below—their chief physical and chemical characters—their preparation—and their characteristic tests.

Oxygen, Hydrogen, Carbon, Nitrogen, Chlorine, Bromine, Iodine, Fluorine, Sulphur, Phosphorus, Silicon.

Combining Proportions by weight and by volume. General nature of Acids, Bases, and Salts. Symbols and Nomenclature.

The Atmosphere—its constitution; effects of Animal and Vegetable life upon its composition.

Combustion. Structure and properties of Flame. Nature and composition of ordinary Fuel.

Water.—Chemical peculiarities of Natural waters, such as rain-water, river-water, spring-water, sea-water.

Carbonic Acid. Oxides and Acids of Nitrogen. Ammonia. Olefant Gas, Marsh Gas, Sulphurous and Sulphuric Acids, Sulphuretted Hydrogen.

Hydrochloric Acid. Phosphoric Acid and Phosphuretted Hydrogen. Silica.

DEGREE OF BACHELOR OF SCIENCE (B.S.C.).

This Degree is conferred on candidates who pass a satisfactory examination in Mathematics, Mechanical and Natural Philosophy, Botany, and Vegetable Physiology, Zoology, and Chemistry.

For the first examination of the Candidate, a knowledge of Inorganic Chemistry only is necessary, including the following subjects:—

Matter—simple and compound.

Elementary bodies classed. Metallic and Non-Metallic bodies.

Chemical Combination and Mechanical Mixture. Solution.

Outlines of Crystallography. Isomorphism. Dimorphism. Allotropic conditions of matter. Chemical Affinity. Laws of Combination by weight and by volume, as deduced from the history of the individual elements. Equivalent Numbers. Equivalent Volumes. Symbolical Notation, including questions on the Unitary System. Formulae. Nomenclature.

Chemical Actions produced under the influence of Heat. Nature of Combustion. Structure and properties of Flame. Principles of Illumination. Chemical action of Light. Photography.

Oxygen. Ozone.

Hydrogen. Water.

Nitrogen. Chemical Constitution of the Atmosphere. Diffusion of Gases. The Oxides of Nitrogen; Nitric Acid. Ammonia.

Chlorine, Bromine, and Iodine. Their compounds with Oxygen and Hydrogen. Theory of Bleaching.

Fluorine and Hydrofluoric Acid.

Sulphur. Sulphurous Acid. Manufacture and Chemical applications of Sulphuric Acid. Other Oxygen compounds of Sulphur. Sulphuretted Hydrogen.

Phosphorus. Oxygen and Hydrogen Compounds of Phosphorus. Theory of Acids. Monobasic, Dibasic, and Tribasic Acids.

Carbon. Carbonic Oxide and Carbonic Acid. The principal Hydrogen compounds of Carbon. Manufacture of Coal Gas.

Silicon and Boron. Their compounds with the elements previously enumerated.

Metals. Characters of metals as a Class. Metallurgical Processes. Alloys. Classification of the Metals.

Potassium. Nitre. Gunpowder. Theory of the action of Gunpowder.

Sodium. Manufacture of Carbonate of Soda.

Barium. Strontium. Calcium. Mortars. Cements.

Magnesium. Aluminum. Glass. Porcelain.

Manganese. Iron. Composition and properties of Cast Iron, Wrought Iron, and Steel. Chromium.

Cobalt. Nickel. Zinc. Cadmium.

Lead. Manufacture of White Lead.

Copper. Mercury. Bismuth. Tin. Arsenic. Antimony. Silver. Gold. Platinum.

Principal compounds of the Metals with the Non-Metallic elements. Theory of Salts.

Principles of Mineral Analysis.

Principles of Electro-Chemistry.

In the Examination for Honours, the Candidate, being not more than twenty-two years of age, who shall most distinguish himself in Chemistry and Natural Philosophy, shall receive an Exhibition of Forty pounds per annum for the next two years.

SECOND B.S.C. EXAMINATION.

This examination embraces Organic Chemistry, including the following subjects:—

Ultimate analysis of Organic bodies. Calculation of Empirical Formulae. Methods of controlling Empirical Formulae. Determination of the Equivalents of organic acids and bases; examination of products of Decomposition; determination of the Vapour-density of volatile bodies.

Law of Substitution. Compound Radicals. Homologous Series.

The Chemical history of the Cyanogen group. Cyanogen. Hydrocyanic Acid. Cyanic Acid and Urea. Fulminates. Cyanuric Acid. Sulphocyanic Acid. Chlorides of Cyanogen. Uric Acid.

Amylaceous and Saccharine substances. Fermentation. Alcohol, Wine, Beer, Bread, &c.

Homologues of Alcohol. Ethers, simple and mixed. Oxidation of Alcohol. Aldehyde and Acetic Acid and their homologues. Anhydrides, simple and mixed. Compound Ethers.

Diatomic Alcohols and their Acids. Glycol and Oxalic Acid and their homologues.

Triatomic Alcohols. Glycerine. Fatty and Oily bodies. Saponification.

Vegetable Acids—the principal.

Ammonia and its derivatives. Ammonium and Ammoniacal Salts. Amides and Amines: their Classification. The chief natural Organic Bases.

Colouring Matters. Indigo and its derivatives. Principles of Dyeing.

The chief constituents of the Vegetable organism. Cellulose. Vegetable Fibrin. Albumin, Casein, Glutin, &c.

The chief constituents of the Animal organism. Animal Fibrin, Albumin, Casein, Gelatin. Blood, Milk, Bile, Urine, &c.

Decay, Putrefaction. Destructive Distillation.

The Chemical principles of the process of Nutrition and of Respiration in Plants and Animals.

The Candidate, not more than twenty-three years of age, who, in the Examination for Honours, shall most distinguish himself in Chemistry, shall receive Fifty pounds per annum for the next two years, with the title of University Scholar.

D.S.C. EXAMINATION.

Candidates are not admitted to this Examination until after the expiration of two Academical years from the time of their obtaining the degree of B.Sc. Chemical candidates can be examined either in Inorganic or Organic Chemistry. A Certificate under the seal of the University, and signed by the Chancellor, shall be delivered at the Public Presentation for Degrees to each candidate who has passed.

EXAMINATIONS IN CONNEXION WITH THE DEPARTMENT OF SCIENCE AND ART, SOUTH KENSINGTON.

A sum of money is voted annually by Parliament for scientific instruction in the United Kingdom.

This sum is administered by the Science and Art Department.

The object of the grant is to promote instruction in Science, especially among the industrial classes, by affording a limited and partial aid or stimulus towards the founding and maintenance of Science schools and classes.

The following are among the Sciences towards instruction in which aid is given:—Acoustics, Light, Heat, Magnetism and Electricity, Inorganic Chemistry, Organic Chemistry, Geology, Mineralogy, Mining, Metallurgy.

The assistance granted by the Science and Art Department is in the form of—1. Public Examinations, in which Queen's Medals and Queen's prizes are awarded, held at all places complying with certain conditions. 2. Payments on results to teachers. 3. Scholarships and exhibitions. 4. Building Grants. 5. Grants towards the purchase of apparatus, &c.

Examinations in all the before-mentioned Sciences are held annually about May, through the agency of the Local Committee (which must consist of not less than five well known responsible persons) in any place in the United Kingdom which complies with the requisite conditions. The Examinations are of two kinds, but held on the same evening and conducted by the same committee. *a.* The class examinations for students under instruction in Science Classes, whether taught by teachers qualified to earn payments on results or not. *b.* The honours examination of a highly advanced character.

The class examination is of two grades or stages; the first stage or elementary examination, and the second stage or advanced examination.

Application for examination must be made before the end of March, stating the number of persons and the subject or subjects in which they are to be examined.

At the May class examinations the grades of success are:—in the first stage or elementary paper, first, second, and third class; and in the second stage or advanced paper, first and second class. For the third or lowest class the standard of attainment is only such as will justify the Examiner in reporting that the instruction has been sound, and that the students have benefited by it. The standard may be raised from year to year.

To all successful students are given printed lists of results showing their position. To the first class in both stages Queen's Prizes are given, consisting of Books or Instruments, chosen by the candidates from lists furnished for that purpose.

Four medals, one gold, one silver, and two bronze, are given in each subject for competition among the *bond fide* students of Science Classes who either come within the category of persons on account of whom payments can be earned, or who are under seventeen years of age. The Payments on Results are made either directly to teachers or to the committee or managers of the school. Persons are qualified to earn payments who have—*a.* obtained certificates as teachers in any of the before-mentioned sciences according to the rules

in force previous to January, 1867; or, *b.* obtained a First or Second Class at the May examination since that date; or, *c.* who have taken honours at the May examination.

No payments are made to a teacher on account of instruction given in subjects in which he is not so qualified.

The student must have received 25 lessons at least from the teacher or teachers in each subject in which payment is claimed since the last examination, each lesson being an attendance at a meeting of the school of at least three-quarters of an hour's duration on a separate day.

There are two Scholarships provided—the Elementary School and the Science and Art Scholarships. In both cases the scholar must be from 12 to 16 years of age, and must have passed in a branch of science at the May examination.

Building Grants for New Schools may be made at a rate not exceeding 2s 6d. per square foot of internal area, up to a maximum of £500 for any one school, under certain conditions.

A grant towards the purchase of apparatus, diagrams, &c., of 50 per cent on the cost of them, is made to Science Schools and Classes in Mechanics' and similar institutions with a properly constituted committee.

Science teachers who have taught two years consecutively, and passed not less than thirty students each year, are allowed second class railway fare and £3 towards their expenses while living in London for the purpose of visiting the South Kensington Museum and other Metropolitan institutions, in order that they may acquire for the benefit of their students a knowledge of the latest progress in those educational subjects which affect the schools, on condition that they remain there five days at least.

The fifteenth Report of the Science and Art Department gives the following information:—

The system of Science and Art instruction has reached 10,230 individuals in Science, and 105,529 individuals in Art. The Students at the School of Naval Architecture numbered 44, at the School of Mines 13 regular and 102 occasional, and at the College of Chemistry 121. At the evening lectures there was a total attendance of 2,207.

At the Royal College of Science for Ireland there were 35 individual students; 4,958 persons attended the various courses of lectures which were delivered during the year in connection with the Department in Dublin; and a course of lectures at the Edinburgh Museum of Science and Art was attended by 790 persons.

The total number of persons, therefore, who have received direct instruction as students, or by means of lectures, in connection with the Science and Art Department, is about 123,500, being an increase of over 10,000, or nearly 9 per cent, on 1866, when the numbers were about 113,000.

The attendance at the museums and collections under the superintendence of the Department in London, Dublin, and Edinburgh has been 1,305,374, showing a total increase of 152,374, or 13.2 per cent on the numbers of the preceding year, which were 1,153,091.

The attendance at the Educational and Art Libraries, and at the library of the Royal Dublin Society, shows a satisfactory progress. The numbers in 1867 were 32,665, or 5.392 more than in the preceding year.

The returns received of the number of visitors at various local exhibitions to which objects of art were contributed from the Art Museum, show an attendance of upwards of 62,000 persons.

The expenditure of the Department during the financial year 1866-7, exclusive of the cost of the geological survey, was £152,856 18s. 1d., while in 1867-8 it was £179,950 6s. 1d., showing an increase of £27,093 8s.

UNIVERSITY COLLEGE.

WINTER TERM.

Chemistry.—Professor Williamson, Ph.D., F.R.S.

Daily, except Saturday, from 11 till 12 A.M.

Fee for a Half Course, £3 3s.; for the Whole Course

£6 6s.; Perpetual, £9 9s.; for the Organic Course alone, £2 2s.

The First Half of the Course to Christmas includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

The following order of subjects is adopted in it:—

Heat.—Instruments for Measuring Temperature. Decompositions produced by Heat. Expansion. Tension of Vapours. Conduction. Convection. Calorimeters. Specific Heat. Latent Heat. Evolution of Heat by Chemical Action, and by Mechanical Action. Mechanical equivalent of Heat.

Light.—Photometry. Refraction and Dispersion of Light. Study of Spectrum. Heat Rays. Chemical Rays. Construction of common Optical Instruments. Double Refraction. Polarisation. Chemical Applications of phenomena of Polarisation. Combinations and Decompositions produced by Light and Actinic Rays. Photography.

Electricity and Magnetism.—Simple Magnetic Instruments. Magnetic and Diamagnetic Bodies. Electrical Machine. Electrophorus, &c. Positive and Negative Electricity. Electrometers. Conduction. Induction. Leyden jars, &c. Discovery of Galvanism. Various forms of Battery. Study of the Chemical Action of Galvanic Batteries. Galvanometers. Heating Effects of Battery in relation to Chemical Action. Thermo-Electricity. Rheostat, &c.

Oxygen.—Theory of Combustion. Hydrogen. Nitrogen. Composition and Chief Changes of the Atmosphere. Carbon, Chlorine, Bromine, Iodine, and Fluorine. Sulphur, &c. Phosphorus. Boron. Silicon.

The chief compounds of these non-metallic elements among themselves are studied in relation to their production, properties, and decompositions. The proportions by weight and by volume in which they combine are explained and illustrated in connection with the atomic theory.

The Second Half of the Course, extending from January to March, includes the following subjects:—

Preparation and Properties of the Chief Metals, including their Characteristic Reactions and most important Salts. Detection of Metallic Poisons. Quantitative Estimation of Metals. Principles of Classification. Monatomic, Diatomic Metals, &c.

A weekly *videlicet* examination is held during the First Half Course and the commencement of the Second Half Course.

Organic Chemistry.

This commences in the second week in February, and occupies five Lectures weekly till about the end of March. It includes a study of the Characteristics and Metamorphoses of the chief Organic Acids, Bases, Alcohols, Ethers, Colouring Matters, &c. Methods of Ultimate and Proximate Analysis. Determination of Molecular Weights. Theory of Types; of Compound Radicals. Phenomena of Fermentation, &c.

SUMMER TERM.

Practical Chemistry.—Professor Williamson, Ph.D., F.R.S.

I. Elementary Course.

About Forty Lessons of one hour each, on Tuesday, Wednesday, Thursday, and Friday, from 11 to 12, commencing in the first week of May. Students are taught the construction and use of apparatus for the preparation of the most important gases, acids, &c. The characteristic tests for the presence of the common acids and bases, including the chief metallic and other poisons. Also the processes for separating these bodies from one another.

Solutions are frequently given in the class for investigation.

The first six weeks of the Course are occupied by the study of the chief non-metallic elements and their simple compounds. Metallic salts, &c., are subsequently studied.

Fee for the course, £4 4s., including the cost of materials and apparatus.

II. Senior Course.

About Ten Lessons, of two hours each, on Mondays, from

10 to 12, commencing in the first week in May. The Course includes tests for fixed and volatile organic acids, nitrogenized acids, sugars, glycerine, &c., organic bases and alkaloids, constituents of blood, milk, urine, &c.

Volumetric methods of quantitative analysis of acids, alkalies, urea, prussic acid, iron, &c., are practised.

Fee for the Course, £2 2s., including cost of materials and apparatus.

III. Summer Matriculation Course.

Professor Williamson, F.R.S., assisted by Mr. F. S. Barff, M.A., F.C.S.

This Course includes those parts of Chemistry which are required for the Matriculation Examination of the University of London.

The Course consists of about Twenty Lessons in Practical Chemistry, and of an equal number of oral lessons. The practical lessons include the preparation of the common gases and acids, &c., and the study of their characteristic properties in relation to the elementary laws of combination.

The other lessons are chiefly devoted to those parts of the subject which require fuller oral explanation than is given in the practical lessons. They include numerous exercises and questions, to which answers in writing are given by the Students. These lessons will begin on Wednesday, April 8th, at 11 a.m.

The Class will meet on the first five week days, from 11 to 12; and some other meetings will be announced when the Class has assembled.

Fee for the Class, £4 4s., including cost of materials and apparatus.

Analytical and Practical Chemistry.

Birkbeck Laboratory.

The instruction in the laboratory is intended for beginners as well as for more advanced students. It includes practice in the construction and use of apparatus for preparing the common gases, acids, bases, salts, &c.

Study of the qualitative methods of detecting and separating mineral or organic bodies from one another. Also quantitative analysis in the wet way, organic analyses, vapour densities, &c. Instruction in gas analysis.

More advanced students are instructed in the methods of original research, especially in organic chemistry.

When accompanied or preceded by attendance on the lectures on Chemistry, the Laboratory Course qualifies Students in the application of Chemistry to the Manufacturing Arts, Metallurgy, Medicine, or Agriculture, &c. Instruction is given in the principles and processes of gas-analysis.

The Laboratory and offices are fitted up completely with the most improved apparatus and utensils for experimental research, both for beginners and advanced Students. They are open daily from 9 a.m. to 4 p.m., from the 3rd of October until the end of July, with a short recess at Christmas and Easter. Saturday, from 9 to 2.

Fee for the Session, 25 guineas; six months, 18 guineas; three months, 10 guineas; one month, 4 guineas; exclusive of the expense of materials. A deduction of about 40 per cent is made for Students who can attend only three fixed days per week.

EVENING CLASSES.

Elementary Chemistry—Theoretical and Practical.

Professor Williamson, F.R.S. Monday, from 7.30 to 9.30. A Course of Twenty Lessons, of two hours each, in the Michaelmas and Lent Terms.

The elements of Chemistry are explained to the Class, and the experiments illustrating the subject are performed by the Students.

The subject will be the common non-metallic elements and the common metals, their compounds and chief properties, and the best methods of distinguishing and separating them.

All the experiments and analyses are repeated by each Student, or by not more than two Students jointly.
Fee, including the cost of materials, &c., £2 2s. per Term.

CHEMICAL LECTURES.

ROYAL SCHOOL OF MINES AND COLLEGE OF CHEMISTRY.

Chemistry.—Professor: Dr. E. Frankland, F.R.S.

The instruction in Chemical Science embraces:—

1. A Course of Lectures on Experimental Chemistry with special reference to the applications of Chemistry in the Arts and Manufactures.

2. A systematic Laboratory Course for the Practice of Chemical Analysis.

Chemical Lectures.—The Course consists of Forty Lectures on Mineral Chemistry and Thirty Lectures on Organic Chemistry.

The Lectures are delivered at the Royal College of Chemistry, Oxford Street.

Chemical Laboratory.—The general Laboratory for instruction in chemical manipulation, in qualitative and quantitative analysis, and in the method of performing chemical researches, is under the direction of Dr. Frankland. The Royal College of Chemistry having become the property of the Government, its Laboratories are used for the instruction of the pupils of the Royal School of Mines.

There are three terms in the collegiate year, of three months each, commencing in the first weeks of October, January, and April respectively. The Laboratory hours are from 10 a.m. to 5 p.m., with the exception of Saturdays, when the Laboratory closes at two o'clock.

Each Laboratory Student works independently, there being no classes. All operations are superintended by the Professor and his Assistants. A table with drawers, cupboards, and shelves, is appropriated to every pupil. The Institution supplies gas, fuel, and reagents. The larger and more expensive instruments of the Laboratory, such as air-pumps, thermometers, barometers, condensers, &c., may be used by the students, who are held responsible for their safety. The students have to provide themselves only with the apparatus specified in the Laboratory regulations. More advanced students engaged in private researches have to supply themselves with such materials as are not included amongst the ordinary reagents of the Laboratory.

Metallurgy.—Professor: Dr. Percy, F.R.S.

The course of instruction in Metallurgy consists of Lectures and Laboratory practice.

The object of the Lectures is the communication of such instruction as the student may be able to apply to the greatest practical advantage, when he may be subsequently engaged in conducting any metallurgical process.

This Laboratory is conducted by Mr. R. Smith, under the direction of Dr. Percy, and is devoted to practical instruction in Metallurgy. The nature of this instruction will be adapted to the special requirements of the student. It comprises:—Assaying in all its branches, especially of the more important metals, such as iron, copper, lead, tin, alloys of silver and gold, &c.; and the examination of ores and metallurgical products.

The charge for instruction in the Metallurgical Laboratory is £15 for three months, £12 for two months, and £7 for one month.

Evening Lectures.—This year they will consist of two courses, and will be of so strictly educational a character as to meet the wants of the training masters who desire to profit by the Science Minute of the Lords of the Committee of Council on Education. The subjects and order of succession of the courses will be—Chemistry, Physics.

KING'S COLLEGE.

Professor of Chemistry.—W. A. Miller, M.D. V.P.R.S.

Professor of Practical Chemistry.—G. L. Bloxam.

Demonstrator.—J. T. Bottomley, M.A.

Students of the first and second years are admitted to the Course of Theoretical and Applied Chemistry. The Course commences with a view of the forces which concur to the production of Chemical Phenomena, after which the laws of Chemical Attraction are discussed, and the Non-metallic Elements and their principal Compounds are described.

The metals and their principal compounds are next examined, care being taken to point out the applications of the Science to the Arts, and the processes of the different Manufactures, of Metallurgy, and of Domestic Economy, are explained and illustrated.

Examination of the Class, both *visd voce* and by written papers, are held at intervals during the course at the usual Lecture hour. Dr. Miller has published a work on Chemistry, which is used as a text-book by the Class.

Third Year.—Students who have completed six Terms in this department are admitted to a Course of "Practical Chemistry," consisting of twelve Demonstrations in each term; and they go through a course of Manipulation in the most important operations of Chemistry, including the first steps of Analysis.

Any Student of this department may be admitted to this Class at any period of his study on payment of an extra fee.

Experimental and Analytical Chemistry in the Laboratory.—The object of this Class is to afford to Students who are desirous of acquiring a knowledge of analysis, or of prosecuting original research, an opportunity of doing so under the superintendence of the Professor and Demonstrator; Students may enter, upon payment of the extra fees, at any time except during the vacation, and for a period of one, three, six, or nine months, as may best suit their convenience. The Laboratory hours are from ten till four daily, except Saturday, on which day the hours are from ten till one.

In addition to the Laboratory Fee, each Student defrays the expenses of his own experiments. The amount of this expense, which is comparatively trifling, is entirely under his own control.

EVENING CLASSES.

Classes for Evening Instruction are held at King's College, from October to March, and during April, May, and June.

The Classes include one for the Elements of Chemistry, and one for Practical Chemistry.

The fee for the former is £1 11s. 6d.; for the latter, £2 2s. The Classes meet twice a week.

LECTURES AT LONDON MEDICAL SCHOOLS.

ST. BARTHOLOMEW'S HOSPITAL AND MEDICAL COLLEGE.

WINTER SESSION.

Lecturer.—William Odling, M.B., Lond., F.R.S., Fellow of the Royal College of Physicians, Fullerian Professor of Chemistry at the Royal Institution. Monday, Wednesday, and Friday, at 10 a.m.

SUMMER SESSION.

Practical Chemistry.—Dr. Odling, F.R.S.

CHARING-CROSS HOSPITAL AND COLLEGE.

WINTER SESSION.

Lecturer.—Mr. C. W. Heaton, F.C.S. Monday, Wednesday, and Friday, at ten. One session, £5 5s.
The Laboratory is open daily.

SUMMER SESSION.

Practical Chemistry.—Mr. Heaton, F.C.S. Monday, Wednesday, and Friday. One session, £2 2s.

ST. GEORGE'S HOSPITAL.

WINTER SESSION.

Lecturer.—Dr. H. M. Noad, F.R.S. Tuesday, Thursday, and Saturday, at half-past eleven. One course, £6 6s.

SUMMER SESSION.

Practical Chemistry.—Dr. Noad, F.R.S. Daily, at ten. One course, including the use of apparatus and materials, £4 4s.

GUY'S HOSPITAL.

WINTER SESSION.

Lecturer.—Dr. Alfred Taylor. Tuesday, Thursday, and Saturday, at eleven. One course, £4 4s.

SUMMER SESSION.

Practical Chemistry.—Dr. Stevenson. Monday, Wednesday, and Friday, from ten to one. One course, £4 4s.

LONDON HOSPITAL.

Lecturer on Chemistry.—Dr. Letheby, M.A., &c.

ST. MARY'S HOSPITAL.

WINTER SESSION.

Lecturer.—Dr. Russell, F.C.S. Monday, Tuesday, Thursday, and Friday, at 10.15.

SUMMER SESSION.

Practical Chemistry.—Dr. Russell, F.C.S. Tuesday, Thursday, and Saturday, from 11.30 to 1 p.m. One session, £3 3s.

MIDDLESEX HOSPITAL.

WINTER SESSION.

Lecturers.—Mr. Taylor and Mr. Heisch. Monday, Wednesday, Friday, and Saturday, at eleven. One session, £6 6s.

SUMMER SESSION.

Practical Chemistry.—Mr. Taylor and Mr. Heisch. Monday, Wednesday, and Friday, at eleven. One session, £3 3s.

ST. THOMAS'S HOSPITAL.

WINTER SESSION.

Lecturer.—Dr. A. J. Bernays. Tuesday, Thursday, and Saturday, at eleven.

SUMMER SESSION.

Practical Chemistry.—Dr. A. J. Bernays. Tuesday and Thursday, ten to twelve; Friday, eleven; Saturday, ten to one.

WESTMINSTER HOSPITAL.

WINTER SESSION.

Lecturer.—Dr. A. Dupré, F.C.S. Tuesday and Thursday, at three p.m.; Friday at 10.30 a.m. One course, £5 5s.

SUMMER SESSION.

Practical Chemistry.—Dr. A. Dupré, F.C.S. Tuesday and Thursday, at 10.30 a.m. One course, £2 2s.

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN,
17, BLOOMSBURY SQUARE, W. C.

School of Pharmacy. The session (1868-9) will commence on Thursday, October 1st, and extend to the end of July.

LECTURES ON CHEMISTRY AND PHARMACY, BY DR. REDWOOD.

These Lectures will be delivered on Monday, Tuesday, and Wednesday mornings, at half-past eight o'clock, commencing on Monday, 5th October.

Part 1.—Physics in relation to Chemistry and Pharmacy.

" 2.—Chemistry of Inorganic Bodies.

" 3.—Chemistry of Organic Bodies.

Also Lectures on Botany and Materia Medica, by Professor Bentley. The first and second parts of this course, extending

over the winter months, will be delivered at 17, Bloomsbury Square, on Friday and Saturday mornings, at 8.30, commencing on Friday, October 2nd. The third part of the course, on Systematic Botany, will be delivered at the Royal Botanic Gardens, Regent's Park.

Fees.—For registered apprentices and associates of the Society, for either of the above courses, £1 1s.; for either part, separately, 10s. 6d. For those not connected with the Society, £2 2s. for either of the above courses; £1 1s. for either part separately. Students have free admission to the library and museum.

Laboratory.—The suite of Laboratories for Practical Instruction in General and Pharmaceutical Chemistry will be opened on Thursday, the 1st October, under the direction of Professor Atfield. Fee for the entire session of ten months, Twenty-five Guineas. The Laboratories are open from half-past nine a.m. till five p.m. Students can enter at any period during the session.

Two Scholarships (the Jacob Bell Memorial Scholarship), of Thirty Pounds a year each, are open to competition annually in July.

The Board of Examiners meet monthly, and are required by the Pharmacy Act to examine "all candidates who may present themselves for examination in their knowledge of the Latin Language, in Botany, in Materia Medica, in Pharmaceutical and General Chemistry, and to grant Certificates of Competency.

CITY OF LONDON COLLEGE, LEADENHALL STREET, E.C.

Lecturer.—Rev. B. W. Gibsons, M.A., B. Sc. Monday evenings from seven to nine p.m.

The annual Courses consist of three terms, each averaging ten experimental lectures; fee, 5s. per term. Subjects: Junior Class, Chemistry; first year, Non-metals; second year, Metals and (time permitting) Elements of Organic Chemistry. Senior Class, seven to eight p.m., Practical Analysis.

ROYAL VETERINARY COLLEGE, CAMDEN TOWN.

Chemical Professor.—Mr. R. V. Tuson.

The Session commences on October 1st

PRIVATE TEACHERS OF CHEMISTRY IN LONDON

Mr. F. C. Braithwaite, 54, Kentish Town Road, N.W.—Chemistry and Toxicology, Monday and Thursday; Latin, Tuesday and Friday; Botany and Materia Medica, Wednesday and Saturday. All the classes commence at eight p.m. Laboratory open daily, except Saturdays.

Professor E. V. Gardner, F.C.S.—College of Experimental, Military, and Naval Sciences, 44, Berners Street, W. Laboratory and Class Rooms open daily.

Mr. Henry Mathews, F.C.S.—Laboratory, 60, Gower Street, Bedford Square. Instruction in all branches of Practical Chemistry, particularly in its application to Medicine, Agriculture, and Commerce. Laboratory open daily (except Saturday) from ten to five; on Saturday from ten to one; and from October to March on Monday and Friday evenings from six to nine o'clock.

Mr. A. Vacher, 20, Great Marlborough Street, Regent Street.

Mr. John Newlands, F.C.S.—Laboratory, 19 Great St. Helens, Bishopsgate Street. Gives practical instruction in Analysis, and prepares gentlemen for various public examinations.

Polytechnic Institution.—Course of thirty lessons in Inorganic Chemistry by Mr. G. F. Downar, under the superintendence of Professor Pepper. Tuesday, 8.30 to 10 p.m.

Mr. W. A. Tilden, F.C.S., 19, Compton Street, East Hunter Street, Brunswick Square, W. C.—Evening classes to prepare for the examinations of the Pharmaceutical Society.

UNIVERSITY OF OXFORD.

Professor of Chemistry.—Sir B. C. Brodie, Bart., M.A., F.R.S.

Demonstrator.—E. Madan, M.A.

A commodious Laboratory is attached to the new museum. Scholarships of about the value of £75 are obtainable at Christ Church, Magdalen, and other Colleges, by competitive examination in Natural Science.

UNIVERSITY OF CAMBRIDGE.

Professor of Chemistry.—G. B. Liveing, M.A.

MICHAELMAS TERM.

Practical Chemistry, by the Professor, on Mondays, Wednesdays, and Fridays, at one p.m. Begins October 12.

LENT TERM.

Chemistry, by the Professor, on Mondays, Wednesdays, and Fridays, at twelve. Begins January 27.

Practical Chemistry, on the same days, at one p.m. Begins January 18.

EASTER TERM.

Chemistry by the Professor, on Mondays, Wednesdays, and Fridays, at twelve. Begins April 7.

Practical Chemistry, on the same days, at one p.m. Begins April 7.

The Chemical Laboratory of the University is open daily from ten a.m. till six p.m., so that Students can work there at such times as may be convenient to them; and the Professor will attend to give instruction at the times above specified.

PROVINCIAL SCHOOLS.

BIRMINGHAM.—MIDLAND INSTITUTE.

Lecturer on Chemistry.—Mr. C. J. Woodward, B.Sc. Tuesday and Thursday at 8 p.m.

Practical Chemistry.—Mr. C. J. Woodward, B.Sc. Saturday, 3 to 6, and 6.30 to 9.30 p.m.

TRADE SCHOOL FOR BIRMINGHAM.

The Council of the Midland Institute are endeavouring to establish a Trade School in Birmingham. At a meeting held a few days since Mr. William Kendrick, the chairman, said the fact had been established that science was in future destined to occupy a much more important place in education than had hitherto been the case, and also that in both primary and advanced instruction England was lamentably behind Continental countries. These facts had alarmed many thinking men, who perceived that, whatever the natural capabilities and advantages possessed by this country in regard to the ready supply of the raw materials, we could not afford to neglect the science which taught them the best uses to make of these materials. Since the attention of Parliament had been drawn to the subject, a good deal of interest had been created by the fact that a trade school, for the purpose of giving scientific instruction, had been established in Bristol for 13 years. There they found what might serve as a model school for the whole country, for it was doing the very work which was so much desired in all the large centres of manufacturing industry. Mr. Samuelson, M.P., through Mr. Dixon, had lately made a communication to the Council of the Midland Institute offering to guarantee £21 for two years towards the expense of establishing such a school in Birmingham. When that communication was made to the council it was felt that it would be very culpable neglect of duty if the matter were allowed to drop, and that the question should be very fully and fairly brought before the manufacturers

of the town and the public at large. The Mayor, Mr. George Dixon, M.P., Mr. Arthur Ryland, and other gentlemen, spoke in favour of the project, and ultimately the following resolution was passed:—"That this meeting approves the scheme now submitted, and recommends that it be adopted by the Midland Institute, and that an appeal be made to the town for the necessary funds—namely, £250 for immediate expenses, and a subscription list of £400 per annum, and that upon these funds being provided a school shall be established."

BIRMINGHAM.—QUEEN'S COLLEGE.

Professor of Chemistry.—Alfred Hill, M.D., Borough Analyst.

Practical Chemistry.—Professor Alfred Anderson.

The Session will commence on October 1st.

BRISTOL.—BRISTOL MEDICAL SCHOOL.

WINTER SESSION.

Lecturer.—Mr. Thomas Coomber, F.C.S.

Monday, Tuesday, Wednesday, and Thursday, at 8.15. One course, £5 5s.

SUMMER SESSION.

Practical Chemistry.—Mr. T. Coomber, F.C.S.

Daily except Saturday, at 8 a.m. One course, £3 3s.

BRISTOL SCHOOL OF CHEMISTRY.

Conducted by Frederick W. Griffin, Ph.D.

A course of Lectures on General Chemistry, commencing in October, and Laboratory instruction throughout the year.

ROYAL AGRICULTURAL COLLEGE,
CIRENCESTER.

Professor.—Mr. A. H. Church, M.A.

Assistant.—Mr. B. J. Grosjean.

The Autumn Session commenced August 10th. Three Courses of Lectures are now being delivered.

Inorganic Chemistry.—Mondays, Tuesdays, and Thursdays.

Organic Chemistry.—Tuesdays and Wednesdays.

Agricultural Chemistry.—Mondays.

Practical Chemistry classes are held as under:—

Manipulation.—Mondays and Wednesdays.

Qualitative Analysis.—Tuesdays and Thursdays.

Quantitative Analysis.—Tuesdays and Thursdays.

The Autumn Session closes about the 18th of December, after the conclusion of the Diploma and Sessional examinations. The Spring Session commences early in February.

LIVERPOOL ROYAL INFIRMARY SCHOOL OF
MEDICINE.

WINTER SESSION.

Chemical Lecturer.—Mr. J. C. Brown, B.Sc., F.C.S.

Four days per week. One course, £5 5s.

SUMMER SESSION.

Practical Chemistry.—Mr. J. C. Brown, B.Sc., F.C.S.

Monday, Tuesday, and Friday, at 10.15. One course, £3 3s.

The Laboratory is open daily from 10 to 4.

COLLEGE OF CHEMISTRY, LIVERPOOL.

Principal.—Dr. Sheridan Muspratt, F.R.S.E., M.R.I.A., F.C.S., &c.

Assistant.—Mr. Martin Murphy, F.C.S.

The course of instruction in this college is entirely devoted to Laboratory work. The term is three months and dates from time of entrance. Fee for working, 5 days per week, £12 12s.; five days, £11 11s.; four days, £10 10s.; three days, £9 9s.; two days £8 8s.; and

day per week, £6 6s. Hours of attendance from 10 a.m. till 5 p.m. The students' laboratories close at 1 o'clock p.m. on Saturdays.

Medical students may enter for one hour per day per session. Fee, £3 3s. Certificates of attendance recognised by the University and Apothecaries' Hall of London, and the Apothecaries' Hall of Ireland.

LEEDS SCHOOL OF MEDICINE.

WINTER SESSION.

Lecturer.—Mr. J. Chapman Wilson, F.C.S.

Daily, except Saturday, at 11 a.m. One course, £4 4s.

SUMMER SESSION.

Practical Chemistry.—Mr. Wilson, F.C.S.

Tuesdays and Thursdays, 11 to 12.30. One course, £2 2s.

LEEDS MECHANICS' INSTITUTION AND LITERARY SOCIETY'S LABORATORY.

SESSION 1868-69.

Chemical Classes for instruction in Elementary, Practical, and Analytical Chemistry.

Teacher.—Mr. George Ward, F.C.S.

The usual Sessional Course of Instruction in abstract and Applied Chemistry will commence on Thursday, October 1st, at 8 p.m., on which evening the teacher of the classes will introduce the general subject in a Lecture explanatory of its principles, of the mode in which these should be studied, and also of the plan which he purposes to adopt in conducting the Classes during the Session.

Fees payable in advance: Elementary Chemistry, Thursday, per session, £1 15s. or 5s. 6d. per month. The subscription includes a selection of apparatus and material specially adapted for the course of instruction. To pupils providing their own materials £1 1s. per session. Organic Chemistry, Friday, per session, 10s. 6d. Practical Chemistry, Tuesday, per session, £1 1s. or 3s. 6d. per month, including apparatus and material. The session extends over seven months, from October to April inclusive.

MANCHESTER ROYAL SCHOOL OF MEDICINE.

Lecturer on Chemistry.—Mr. Daniel Stone.

The usual course for the Medical Boards.

A Laboratory is connected with the school.

OWEN'S COLLEGE, MANCHESTER.

(IN CONNECTION WITH THE UNIVERSITY OF LONDON.)

Chemistry.—Professor H. E. Roscoe, B.A., Ph.D., F.R.S., F.C.S.

Junior Class.—Wednesday and Saturday, from 9.15 to 10.15 a.m.

Subject: Inorganic Chemistry, comprising the laws of chemical combination, and a description of the properties and mode of preparation of the non-metallic elementary bodies, and their most important compounds.

Senior Class.—Tuesday and Thursday, from 9.15 to 10.15 a.m.

Subjects: Inorganic and Organic Chemistry, including the properties of the metals and their compounds, and the composition and relations of the best defined groups of organic bodies, and the laws regulating their formation.

Students are expected to answer the written exercises and attend the *visd voce* examinations given in these classes.

Text books (for both classes): Roscoe's "Elementary Chemistry, 1868," Fowne's "Manual of Chemistry, 1868," and Miller's "Elements of Chemistry."

Fee, for each class, £3 3s. For both classes, £5 5s.

A Recapitulatory Lecture, without additional Fee, will be given on Friday at 9.15 a.m., which members of both classes will be required to attend.

Extra Class.—Wednesday, from four to five p.m.

Subject: Technological Chemistry.

The Chemical Principles involved in the most important Chemical Manufactures will be chiefly considered in this course. The subject will be discussed as follows, and as far as time will permit:—

1. Production of Heat—Heat of Combustion—Combustibles—Coal.
 2. Production of Light—Coal Gas—Measurement of Illuminating Power of Coal Gas—Distillation of Coal.
 3. Water and Air, as regards their Sanitary and Technological Relations.
 4. Processes concerned in the manufacture and application of the Alkalies.
 5. Dyeing and Calico Printing.
 6. Manufacture of Acids.
 7. Manufacture of Glass and Porcelain.
- Students attending this class must be acquainted with the principles of Chemical Science. Fee, £2 2s.

Analytical and Practical Chemistry.

LABORATORY COURSE.

Professor.—Henry E. Roscoe, B.A., Ph.D., F.R.S.

Laboratory Assistant.—Mr. C. Schorlemmer, F.C.S.

The aim of this course is to make the student practically acquainted with Chemical Science, to enable him to conduct analysis and original research, and to fit him for applying the science to the higher branches of Art, Manufactures, and Agriculture. To accomplish this, an attendance of not less than four days per week during three whole sessions is as a rule necessary. It is very advisable that each Laboratory Student should attend or should have attended the course of Lectures on Theoretical Chemistry.

The College Laboratory will be open for students daily from 10.30 a.m. until 5 p.m., except Saturdays, when it will be closed at 1.30. The Laboratory is closed from 1.15 until 2, for dinner.

The Laboratory is fitted with every convenience for the prosecution of practical chemistry, all branches of qualitative and quantitative analysis, and original research. Each student is provided with a separate working table, set of tests, fuel, water, and gas, free of expense; but he is required to find his own apparatus, a few of the more expensive reagents, and the chemicals required for his experiments. Other apparatus or instruments of a more expensive description may be obtained on loan from the Laboratory Stewart, subject to regulations to be prescribed by the Professor.

Fees for the Session.—Students working six days per week, £21; ditto, four days, £17 17s.; ditto, three days, £13 13s.; ditto, two days, £9 9s.; ditto, one day, £5 5s. Students entering the Laboratory Class at or after Christmas, for not less than two days per week, will be charged two-thirds of the fees for the whole Session.

Special Fees for Shorter Periods.—For six months, six days per week, £17 17s.; five months, ditto, £15 15s.; four months, ditto, £13 13s.; three months, ditto, £10 10s.; two months, ditto, £7 7s.; one month, ditto, £4 4s.

Chemical Calculations.—Instruction in the methods of Quantitative Estimation in Chemistry, and intended to supplement the instruction in Practical Chemistry, will be given by Mr. Schorlemmer, on Mondays, from 4 to 5 p.m.

First year's laboratory students are recommended to attend and answer the written exercises and the *visd voce* questions given in this class. Fee, £1 1s.

The Lectures on Chemistry in Owen's College are recognised by the University of London for its Medical Degrees, by the Royal College of Surgeons, and by the Apothecaries' Hall.

NEWCASTLE SCHOOL OF MEDICINE.

(IN CONNECTION WITH THE UNIVERSITY OF DURHAM.)

Lecturer.—Mr. A. Freire Marreco. Four days a week, at a quarter to ten.

The Laboratories are open daily from ten till five. Demonstrations from half-past nine a.m.

SCHOOL OF CHEMISTRY,

1, SURREY STREET, SHEFFIELD.

Mr. A. H. Allen, F.C.S., delivers a course of Thirty Lectures on Inorganic Chemistry, in connection with the Science and Art Department.

Day and Evening Classes for Analytical Chemistry.

SHEFFIELD SCHOOL OF MEDICINE.

During the Winter Session, Mr. A. H. Allen, F.C.S., will deliver a Course of Forty-five Lectures on Chemistry.

SCOTLAND.

UNIVERSITY OF EDINBURGH.

The Session will commence on Monday, November 2nd, 1868.

Professor of Chemistry.—Dr. Lyon Playfair, C.B., F.R.S.

ROYAL COLLEGE OF PHYSICIANS & SURGEONS,
EDINBURGH.

Professors of Practical and Analytical Chemistry.—Dr. Stevenson Macadam and Dr. A. Crum Brown.

The Laboratories open on October 1st.

EDINBURGH VETERINARY COLLEGE.

Professor of Chemistry.—Dr. A. Dalzell, M.R.C.V.S.

ANDERSONIAN UNIVERSITY, GLASGOW.

Professor of Chemistry.—Dr. Penny, F.R.S.E., F.C.S., &c. *Assistants.*—Dr. Clark, Mr. Esilman, Mr. Napier.

1. Systematic Course of Lectures and Demonstrations on Chemistry, for Medical Students, Manufacturers, Civil Engineers, Agriculturists, &c. Daily, except Saturday, from 12 to 1, commencing 27th of October and terminating in April, £2 2s.

The object of this Course, which comprises upwards of 100 Lectures, is to convey to the student a thorough knowledge of the principles of Chemistry, and the applications of the science to medicine, manufactures, agriculture, &c.

Certificates of attendance on these Lectures are received by the Royal College of Physicians of London and Edinburgh; by the Royal Colleges of Surgeons of England, Ireland, and Edinburgh; by the Faculty of Physicians and Surgeons of Glasgow; by the Army, Navy, and East India Boards; and by the Apothecaries' Halls. They also qualify for Graduation in the University of London, &c.

2. Instruction in the various branches of Practical Chemistry and Analysis in the Laboratory. Daily from 10 to 4.

After the usual preparatory training, the attention of the student is specially directed to the examination and analysis of Minerals, products of commerce and manufacture, manures, &c., and, when desired, to original research.

3. The Private Laboratory for commercial and mineral analyses and assays, and for consultations and special investigations. Open daily from 10 to 5 throughout the year.

4. Evening Course of Popular Lectures on the General Principles of Chemistry, and its application to the various branches of the Useful Arts. On Fridays at 8.30, commencing 6th of November, and terminating in April.

Students attending this Course have the privilege of competing for the Prizes and Certificates offered by the Society of Arts, and the Government Department of Science and Art.

5. Evening Course of Instruction in Practical Chemistry and Analysis. On Thursday, from 7 to 9.

6. Summer Course of Practical Chemistry for Medical Students. Three months, commencing in May, £2 2s.

UNIVERSITY OF GLASGOW.

Professor of Chemistry and Practical Chemistry.—Dr. Thomas Anderson, F.R.S.E.

GLASGOW MECHANICS' INSTITUTION.

Lecturer on Chemistry.—Dr Moffatt.

The Course of Twenty-five Lectures this Session will embrace the leading points in the various departments of Chemistry. Several new features will be introduced; amongst others the ultimate Analysis of some Organic and Inorganic Compounds. The modes of Analysis as made in the Laboratory will be shown at the Lecture-table by the aid of new and improved apparatus. Under Scientific Chemistry, an outline of the most recent researches will be given. The Lectures, as formerly, will be largely illustrated by Experiments, Specimens, &c.

The Laboratory is open daily.

CARLTON PLACE SECULAR SCHOOL, GLASGOW.

Teacher.—Mr. John Mayer, F.C.S.

Classes for Chemistry and Metallurgy in connection with the London Society of Arts and the Government Department of Science and Art, on Tuesday and Friday evenings, from 8 till 10, commencing 7th of October.

There is also a Chemistry Class for Teachers on Saturday mornings from 10 till 12.

UNIVERSITY OF ABERDEEN.

Chemistry and Practical Chemistry.—Professor Brazier, F.C.S. Fee to each Course, £3 3s.

The Winter Session commences October 28th.

IRELAND.

DUBLIN.—TRINITY COLLEGE.

Professor of Chemistry.—Dr. Apjohn, F.C.S.

The Lectures will commence on Wednesday, November 2nd, at 2 o'clock, and be continued each Tuesday, Thursday, and Saturday.

ROYAL COLLEGE OF SURGEONS, DUBLIN.

Professor of Chemistry.—Dr. Barker.

The Professor receives operating pupils into the Chemical Laboratory.

QUEEN'S COLLEGE, BELFAST.

Professor of Chemistry.—Dr. Andrews.

QUEEN'S COLLEGE, CORK.

Professor of Chemistry.—Dr. Blyth.

QUEEN'S COLLEGE, GALWAY.

Professor of Chemistry.—Dr. T. H. Rowney.

A Laboratory for Practical Instruction is attached to all the Queen's Colleges. The usual practical Course for the Medical Boards is given in the Summer.

NEW SCIENTIFIC SCHOOLS IN PARIS.

ECOLE DES MINES OF SAINT ETIENNE.

The course of study is entirely gratuitous, and includes the following subjects:—The working of mines; the nature of the strata and their principal mineral elements; the art of assaying and of treating minerals; the elements of mathematics; the powers of resistance; and the general nature and mode of employment of materials used in the construction and working of mines, workshops, and transport ways; book-keeping by double entry; and mechanical drawing.

Diplomas of capacity of several degrees will be granted to the pupils on the completion of their studies. The conditions of admission are laid down in a programme to be obtained at the offices of the Minister of commerce; the candidates must possess a knowledge of the French language, arithmetic, geometry, algebra, rectilinear trigonometry, and

descriptive geometry, to the extent required for the degree of bachelor of sciences; of Chemistry to the same extent, metallurgical chemistry excepted; a good knowledge of natural philosophy; and the elements of linear and free-hand drawing, and practical geometry.

The candidate must be not under 16, and not over 25 years of age.

A New School is being formed, which will consist of four sections:—1, Mathematics; 2, Natural Philosophy and Chemistry; 3, Natural History and Physiology; 4, Historical Science and Philology; to which may be added hereafter a fifth section for juridical studies.

The sites will be the Amphitheatres and the Laboratories of the Government Institutions; the Professors, those of the College of France, of the Museum, of the Sorbonne, &c.

REPORTS OF SOCIETIES.

ACADEMY OF SCIENCES.

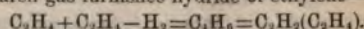
PARIS, JULY 27TH, 1868.

Direct Transformation of Marsh Gas into more condensed Hydrocarbons.—New Reagent for the Determination of Carbonic Acid in Combination.—Colouring Matters derived from Orcine.

At the meeting of the Academy on the 27th of July, M. Berthelot communicated a memoir "On the Direct Transformation of Marsh Gas into more condensed Carbides;" M. Lorry, a memoir relative to "A new Reagent for the Determination of Carbonic Acid in combination in Bicarbonates and in Natural Waters;" and M. de Luynes, a memoir "On the Colouring Matters derived from Orcine."

Whenever marsh gas is formed, either by synthesis or by analysis, its formation is accompanied by that of olefiant gas, and of the condensed carbides, C_nH_{2n} . To interpret this result, M. Berthelot had believed up to the present that a portion of the marsh gas combines, in the nascent state, with another portion of the same carbide with loss of hydrogen. Thus ethylene is first formed; this in its turn acts upon the marsh gas, giving rise to propylene, then butylene. To demonstrate this, marsh gas, carefully purified, is made to pass through a tube of porcelain heated to moderate redness; a considerable quantity of olefiant gas and of more condensed homologous carbides, such as propylene, may be collected. Ethylene is the most abundant of the C_nH_{2n} carbides formed by the condensation of marsh gas. M. Berthelot prepared some marsh gas at a low temperature of more assured purity than that obtained from acetates. Several litres of very pure marsh gas were obtained, and the production of the C_nH_{2n} carbides repeated. The proportion of ethylene regenerated from its bromide (the hydrocarbons were collected as bromides, which were separated by distillation) amounted to more than 10 centimetres for every litre of marsh gas employed, notwithstanding the loss entailed in purifying the bromides.

The formation of acetylene is in relation to that of ethylene—in fact, ethylene is partially decomposed at a red heat into acetylene and hydrogen, $C_2H_4 = C_2H_2 + H_2$. Acetylene and hydrogen are produced in the nascent state, and yet these bodies in the free state reproduce ethylene. Between these three gases there is produced at redness a sort of equilibrium, which maintains so well that it is not troubled by the slower progress of molecular condensations. These notions lead to the acknowledgment of the existence of hydride of ethylene, C_2H_6 , in the same media. M. Berthelot has, in fact, found that hydride of ethylene is formed by the direct reaction of ethylene and free hydrogen; reciprocally free hydride of ethylene is decomposed in part into hydrogen and ethylene. This led to the examination of whether marsh gas would engender, by its transformation, hydride of ethylene. Although the detection of a small quantity of this carbide is much more difficult than that of ethylene or acetylene, M. Berthelot thinks to have succeeded in demonstrating the existence of hydride of ethylene, in taking advantage of the much greater solubility of this carbide over marsh gas in alcohol. Several litres of alcohol were saturated with the marsh gas from the reaction; the part dissolved was disengaged by ebullition, and treated again with a quantity of alcohol insufficient to dissolve the whole; the boiling was repeated until five series of operations had been made, until the last amount of gas obtained was reduced to a few cubic centimetres. According to the analysis, the last sample of gas obtained was formed of 7.5 of hydride of ethylene, and 92.5 of marsh gas. Thus the transformation of free marsh gas furnishes hydride of ethylene—



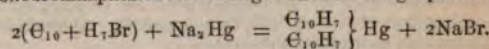
This transformation then gives birth to the three carbides, which contain four equivalents of carbon—acetylene, ethylene, and hydride of ethylene—and these carbides are bound to each other and to hydrogen by the relations of equilibrium, so that the formation of any one of these gases necessitates the formation of the two others.

Orcine is a colourless crystalline substance which possesses, as Robignet has demonstrated, the property of becoming transformed into a violet colouring matter (orceine), under the influence of air and an aqueous solution of ammonia. This colouration is obtained in the presence of water, ammonia, and the oxygen of the atmosphere. The simultaneous presence of these three agents is necessary; without water there is no colouration. The following are some experiments M. de Luynes has made:—Into a sufficiently large thermometric tube he introduced an aqueous and boiled solution of orcine, together with ammonia and some oxidising reagents. A quantity of the liquid having entered, the tube was drawn off nearly at right angles, and the air having been expelled, the tube was sealed and afterwards heated to 50°. With bichromate of potash or ammonia, the solution assumes an intense blue tint; ammoniacal sulphate of copper is slowly, but completely, reduced. Arsenic acid is likewise reduced; arsenious acid gives no result. M. de Luynes finds orcine to yield two distinct products—a violet resinous matter, soluble in ammonia, and a crystalline matter, superficially coloured, which colours deeply by contact with acids and alkalies. The resinous matter constitutes 80 per cent of orcine, and the crystalline matter 20 per cent.

CHEMICAL NOTICES FROM FOREIGN SOURCES.

Phosphorus a Reagent for Metals.—W. Schmid. When a solution of crystallised phosphorus in carbonic disulphide is shaken with water, a perfectly white precipitate is formed. The presence of traces of metals causes the precipitate to assume various colours. Thus solutions of copper are precipitated brown; those of silver, black; of mercury (oxide), yellowish brown; of gold, violet. The filtrates contain generally suboxides. (*Zeitschr. Ch., N.F.* iv., 161.)

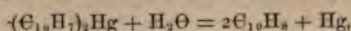
Mercuric Naphtyle.—R. Otto and G. Möriès. Mercuric naphtyle is attained by the action of sodium amalgam upon monobromnaphtalene according to the following equation:—



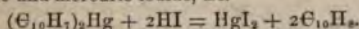
The bromnaphtalene used in this reaction was prepared according to Glaser's method, i.e., by acting with bromine upon naphtalene dissolved in carbonic disulphide, and subjecting the raw material to fractional distillation. Its boiling point was found at 277°—278°C.

Mercuric naphtyle crystallises in small white prisms of the rhombic system, is insoluble in water, sparingly soluble in boiling alcohol, cold benzol, or ether; readily soluble in hot carbonic disulphide and chloroform. It fuses at 243°C.

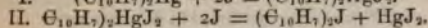
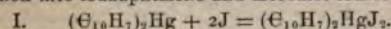
When heated with soda-lime it decomposes in the following manner:—



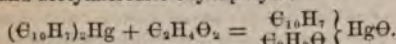
but besides naphthalene a very small quantity of another hydrocarbon is formed, which seems to be dinaphthyl. Iod-brom- or chlorhydric acid decompose mercuric naphthyl into naphthalene and mercuric iodide, &c.



Iodine converts it at first into di-iodmercuric naphthyl (I), and then into iodonaphthalene and mercuric iodide (II):



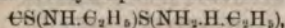
The action of acetic acid gives rise to the formation of naphthalene and acetylmercuric oxynaphthyl:



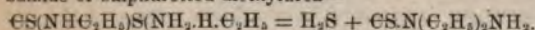
The latter crystallises in white needles, which are insoluble in water, readily soluble in hot glacial acetic acid, alcohol, carbonic disulphide, benzol, chloroform; less soluble in ether. It fuses at 154° . The authors intend to investigate the reaction between mercuric naphthyl and acetic ether, if such there be, with a view of obtaining ethylnaphthalene, and thus opening a way for the production of homologues of naphthalene—(*Ibid.*, N.F. iv., 162.)

Conversion of Benzoic into Anthranilic Acid.—H. Hübner and A. Petermann. The action of bromine upon benzoic acid gives rise to the formation of only one monobromobenzoic acid, which fuses at 153° C. This acid may be successively converted into nitro-compound, β bromamido-benzoic acid (by treating the nitro-body with tin and chlorhydric acid), and an amidobenzoic acid, $\text{C}_6\text{H}_4(\text{NH}_2)\text{COOH}$, which is identical with anthranilic acid, by shaking the brom-amido-acid with sodium amalgam. The acid thus obtained crystallises in long needles, which fuse at 144° C.; and its identity with anthranilic acid is conclusively proved by the fact that when treated with nitrous acid it produces a purple colouration with ferric chloride, a reaction which distinguishes salicylic acid from oxybenzoic and paraoxybenzoic acid (*Ibid.*, N.F. iv., 205).

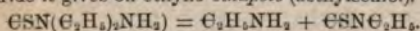
Isomers of Sulphocyanic Ethers.—A. W. Hofmann. If carbonic disulphide is added to an alcoholic solution of ethylamine, the solution becomes heated, and, on cooling, crystals of ethylsulphocarbamate of ethylamine,



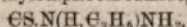
are separated. This salt fuses at 103° C., and is soluble in water and alcohol. The acid, when liberated by means of chlorhydric acid, is obtained in oily drops, which after a time solidify. On heating the salt to 110° — 120° , hydric sulphide is set free, and the residue, after evaporation on the water-bath, solidifies to crystals of diethylsulphocarbamate or sulphuretted diethylurea—



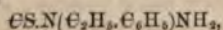
This urea is readily soluble in alcohol, sparingly soluble in water, and fuses at 77° C. When distilled with phosphoric anhydride it gives off ethylic sinapole (aethylsenfol).



Ethylic sinapole is isomeric with the ethylic sulphocyanate which is obtained by heating potassic ethylsulphate with metallic sulphocyanate. Its boiling point is at 143° , being 12° higher than that of ethylic sulphocyanate. It combines with ammonia to ethylsulphocarbamate,



crystals, which fuse at 89° . Diethylsulphocarbamate is obtained by the action of ethylamine upon ethylic sinapole is identical with the compound from which ethylic sinapole is originally derived. Methylsulphocarbamate, $\text{ESN}(\text{C}_2\text{H}_5)_2\text{NH}_2$, is crystalline, and fuses at 54° . Ethylphenylsulphocarbamate,



obtained by acting upon ethylic sinapole with aniline is isomeric with a compound derived from ethylamine and phenylic sinapole; the fusion point of the former is at 145° , that of the latter at 97° . Compounds analogous to those described have also been prepared from the methyl and amyle series.—(*Deut. Chem. Gesellsch.* Berlin, 1868, 25.)

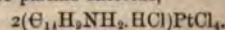
Oxamide from Cyanogen.—R. Schmitt and L. Glutz. If a current of cyanogen gas is passed into aqueous concentrated chlorhydric acid no change of colour takes place; the liquid when allowed to stand for twelve hours separates crystals of oxamide, the mother-liquor containing ammoniac oxalate. Cyanogen and concentrated iodhydric acid likewise produce oxamide; a certain proportion of iodine is set free, and in solution are cyanhydric acid and ammoniac iodide.—(*Ibid.*, 1868, 66.)

Succinic Acid from Chlorpropionic Acid.—A. Eller and H. Wichelhaus. Succinic acid as obtained from chlorpropionic acid by the action of potassic cyanide fuses at 129.5° , dissolves in five parts of water at the ordinary temperature, and its potassic salt gives no precipitate with ferric chloride. The silver salt darkens slightly on drying.—(*Deutsch. Chem. Ges.* Berlin, 1868, 98.)

Strychnia and Ammoniac Sulphhydrate.—A. W. Hofmann. On mixing a cold saturated solution of strychnia in alcohol with an alcoholic solution of ammoniac sulphhydrate containing free sulphur, a separation of orange coloured crystals is observed which is complete after twelve hours. The mother-liquor is poured off, and the crystals are washed with cold alcohol, which renders them chemically pure. They are quite insoluble in water, alcohol, ether, or carbonic disulphide. Their composition is $\text{C}_{21}\text{H}_{22}\text{N}_2\text{O}_2.\text{H}_2\text{S}_2$. When treated with strong sulphuric acid they discolour, and on addition of water oily drops of hydric peroxide are separated. No isomeric compounds could be obtained from quinine, cinchonine, or brucine.—(*Deutsch. Chem. Ges.* Berlin, 1868, 81.)

Camphor and Camphoric Acid.—W. Weyl. If camphoric acid is heated to 200° C. with iodhydric acid (boiling at 127°), iodine and carbonic dioxide are set free, and a hydrocarbon of the composition $\text{C}_{10}\text{H}_{18}$ is formed, which after being washed with water and distilled from sodium, boils at 115 — 118° . From 8 grammes of camphoric acid, 4 c.c. of the purified hydrocarbon were obtained. The latter is insoluble in water, is not acted upon by bromine, but is oxidised, after a prolonged treatment with sulphuric acid and potassic dichromate, at 100° to a crystalline acid which is soluble in water, fuses, and may be volatilised without undergoing decomposition. 20 grammes of camphor treated in a similar manner with IH produced 20 c.c. of a mixture of three hydrocarbons. By means of washing with water and repeated rectifications over sodium, the compound $\text{C}_{10}\text{H}_{18}$, boiling at 135 — 140° , may be separated. A greater portion boils at 163° , and has the composition $\text{C}_{10}\text{H}_{18}$. This latter when again heated with IH to 110° is converted into $\text{C}_{10}\text{H}_{18}$, with the boiling point 170 — 175° . $\text{C}_{10}\text{H}_{18}$ and $\text{C}_{10}\text{H}_{18}$ combine with bromine without elimination of HBr . They are readily oxidised: from $\text{C}_{10}\text{H}_{18}$, four acids were obtained—acetic acid and three others, which require further examination. The author has also investigated the action of iodhydric acid on oil of turpentine, and obtained a hydrocarbon of the boiling point 163° .—(*Ibid.*, 1868, 94.)

Menaphtylamine.—A. W. Hofmann. This compound is formed when an alcoholic solution of menaphtothiamide, $\text{C}_{11}\text{H}_9\text{NS}$ is treated with zinc and chlorhydric acid until the evolution of hydric sulphide has almost ceased. The base is separated by boiling off the alcohol and precipitating with sodic hydrate. It has the composition $\text{C}_{11}\text{H}_9\text{NH}_2$, and boils at 290 — 293° C. Its chlorhydrate crystallises in long needles; the platino-chloride,

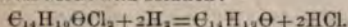


is obtained as a yellow crystalline precipitate. The base, when treated with carbonic disulphide is converted into a mass of white crystals. Alcoholic sodic hydrate and chloroform produce formenaphthyl nitrile.—(*Ibid.*, 1868, 100.)

Crystallised Oxichloride of Antimony and Chloride of Antimony.—L. Schaeffer. Oxichloride of antimony (powder of algaroth.) $2\text{Sb}\text{OCl} + \text{Sb}_2\text{O}_3$, is obtained in crystals of the rhombic system by heating in a sealed vessel 3 molecules of alcohol with 1 molecule of antimonious chloride to 150°C . By heating 1 molecule of alcohol with 1 molecule of antimonious chloride to 160° , the compound SbOCl , chloride of antimony, also in the crystalline state, is formed. The latter is insoluble in alcohol or ether; water slowly decomposes it to oxychloride and chlorhydric acid.—(*Ibid.*, 1868, 135.)

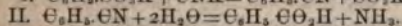
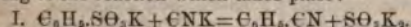
Azobenzid.—P. Alexeyeff. Finely divided zinc with the addition of a small quantity of potassic or sodic hydrate acts upon nitrobenzol in alcoholic solution exactly like sodium amalgam. By the same reagent azobenzid is rapidly converted into hydrazobenzid, and dichlorazoxybenzid into white needles of dichlorhydrazobenzid. Azobenzid, when heated by itself, decomposes to cyanhydric acid, aniline, benzol, diphenyl, and carbon. The author further remarks that the soluble product of reduction of nitroazoxybenzid, discovered by Zinin and examined by Schmidt, shows the same properties as, and probably is identical with, Hofmann's β -phenylenediamine.—(*Akad. z.*, St. Petersburg, 12 [1868], 480.)

Chlorbenzil.—N. Zinin. Chlorbenzil, $\text{C}_{14}\text{H}_{10}\text{OCl}_2$, is readily converted into deoxybenzoin, $\text{C}_{14}\text{H}_{12}\text{O}$, by treating it with zinc and chlorhydric acid when in alcoholic, or with tin when in an acetic acid solution:—



Argentie Cyanide and Sulphuric Chloride.—R. Schneider. If one part of sulphuric chloride (SCl_2), dissolved in ten or twelve parts of carbonic disulphide, is added to two parts of argentie cyanide, an energetic reaction takes place, during which cyanic sulphide $(\text{CN})_2\text{S}$, is formed, together with another compound of unstable nature.—(*Akad. z.*, Berlin, 1868, 31.)

Synthesis of Aromatic Acids.—V. Merz. On a former occasion the author showed that benzoic acid is produced when potassic sulphobenzolate is heated with alcale carbonates. He now describes a method by means of which the synthesis of benzoic acid may be more advantageously effected, and which consists in heating the sulphobenzolate with potassic cyanide, and treating the benzoic cyanide thus formed with an alcoholic solution of sodic hydrate. The following is the reaction which takes place:—



In a similar manner toluic acid may be obtained from potassic sulphotoluylate. From potassic sulphonaphthalate an acid of the composition $\text{C}_{10}\text{H}_7\text{CO}_2\text{H}$, naphthalenecarboxylic acid, was derived,—probably identical with the compound obtained by Hofmann by the action of oxalic acid upon naphthylamine. It separates from a solution in hot water in white crystals, dissolves readily in alcohol and ether, and fuses at 140°C .—(*Zeitschr. Ch. N.F.* iv., 33.)

NOTICES OF BOOKS.

Scientific Blue Books, No. 2. The Ninth Report of the Medical Officer of the Privy Council, with Appendix. London.

THE work under notice deserves to meet with a very extensive sale, from the quantity of information from the pens of Messrs. Simon, Frankland, and Thudicum.

We wish in the first place to draw more particular attention to the work in spectroscopy done by the latter gentleman.

The object of research was to discover if anything peculiar to cholera might be made physically evident; in fact, to detect the virus that the test-tube and microscope have hitherto failed to find.

Some rice-water evacuation from the colon, half an hour after its removal, evolved sufficient gas to lift off the heavy glass stopper of the bottle in which it was contained. As regards this gas, the evidence of incipient fermentation, the following percentages will give valuable information:—

	Nitrogen.	Carbonic Acid.
1st 24 hours' gas	99 per cent.	1 per cent.
2nd " "	52 " "	48 " "
3rd " "	37.5 " "	62.5 " "

During the first twenty-four hours, 400 c.c. of rice-water evolved 75.25 c.c. of gas in a tube over mercury. A flocculent deposit in the discharge forms half of the bulk of the liquid, and consists of epithelium patches, scales, and vibriones; the filtrate could not be obtained quite clear from these bodies, and the deposit further materially interfered with the process of dialysis, decomposition continuing during both filtration and dialysis. The dialysate of the alkaline rice-water had an acid reaction, and gave a crystalline body resembling leucine, combining with nitric acid; an oily substance giving a pink reaction with nitric acid, soluble in water; butyric acid combined with the added barium, inorganic salts in considerable quantity; no urea could be discovered. The fermented clear liquid was then submitted to the spectroscopy; this had not been dialysed, for none of the colouring matters pass through the dialyser. The ingredients of rice-water evacuation (described, by the way, as rice-water throughout the report) are—Vibriones, cells from the surface of the intestine, granular debris of cells, mucine, modified hemochrome, albumen, albuminous body giving rose-pink reaction, butyric acid, acetic acid, ammonia, leucine, inorganic salts. It is in an active state of decomposition, and evolves gas, which at first is composed almost entirely of nitrogen; soon, however, carbonic acid prevails, and ultimately nothing but carbonic acid is evolved. At one period some hydrogen is developed.

The following is an account of the instruments and methods employed by Dr. Thudicum in the spectroscopy examination of the colouring matters of cholera urine:

For the observation of the ordinary non-magnified spectrum, Dr. Thudicum employed a number of spectroscopes of his own construction. These consisted each of a large sulphide of carbon prism. The prism was placed in a drum-shaped dark chamber, to which a tube with a fixed slit and condensing lens was adjusted at the proper angle. The spectrum was seen entire through an oblong opening in the side of the drum. The light was made to pass through the problematical solution; its rays were purified at the slit, made parallel at the lens, and broken prismatically in the sulphide of carbon wedge. The eye at the other side received the entire spectrum as modified by the interposed fluid, and was easily able to define the great features of these modifications by comparison with the normal spectrum when the interposed fluid was withdrawn.

The advantages of such a simple spectroscopy were repeatedly illustrated in the course of these researches by the instantaneous observation of peculiarities, which could not so easily be seen in the magnifying spectroscopy, and might have escaped observation by means of this latter instrument.

Dr. Thudicum also employed a spectroscopy constructed upon the original plan of Bunsen. With this instrument a telescope magnifying about four times was employed. The slit of this instrument was movable, and a glass prism could be adjusted to it, so that the normal and altered spectrum could be made to appear simultaneously the one above the other.

But although valuable observations and general comparisons could be made by these instruments, and although their spectra were of great purity and precision, yet they admitted of no accurate measurements, and the changes of temperature unavoidable in a chemical laboratory, and very great in

a frail wooden structure caused undesirable currents in the sulphide of carbon prisms.

By the side of these instruments a spectrometer by Mr. Ladd was employed, which was provided with two flint-glass prisms, and beside the slit-tube, with a telescope. While in Bunsen's original spectroscopy the entire spectrum is brought into view by turning the prism, in this spectrometer the telescope is made to move upon an arm, which centres somewhere in the middle of the disc which carries the prisms.

This arrangement gave a very good spectrum. By means of the easy motion of the telescope the platinum wire on the diaphragm of the eye-piece could be brought into close adjustment to the margin of any spectral lines or bands. The arm carrying the telescope could then be clamped, and the final adjustment be made by means of a fine-threaded screw. The position of the wire could then be learned by reading the position of the index on the divided quadrant of the disc. The only inconvenience attaching to this instrument was that the observer had to rise after every observation in order to read off the scale. This should be avoided in the construction of any similar apparatus, by engraving the scale on a broad ring, and making it readable through a short system of glasses, having its eye-piece just underneath that of the telescope.

The spectrometer, with diffused sunlight, or the light of a lamp, burning gas, paraffin oil, or tallow, gives a good large spectrum. It was at first attempted to measure this spectrum by determining the D line by means of sodium, and then making this a zero point by measuring from it in two directions. But the description of the direction being found inconvenient, the principal Fraunhofer lines of this spectrum were determined by means of a heliostat. Every change produced in the spectrum by substances to be analyzed could thus be referred to the only fixed points in the spectrum, the lines of Wollaston and Fraunhofer.

But in this process the following difficulty arises. The lines of the entire spectrum cannot be read with the same adjustment of the eye-piece. This difficulty arises with all magnifying spectroscopes, and spectrologists have adopted the device of avoiding it, by seeing their spectra with what is termed "medium clearness." A certain portion of the clearness of one part of the spectrum is sacrificed in order to be able to see with the same adjustment another part of the spectrum, which, if the first were viewed absolutely well defined, would not be defined at all. But with this medium clearness, which serves very well for the spectra of hot metallic gases and for ordinary observation of absorption phenomena, the eye cannot fix the solar lines of the entire spectrum so as to read them off repeatedly with the same accuracy. When proceeding from the red to the violet end of the solar spectrum we arrive at *E* and *b*, or the middle and end of green, at a region where it becomes necessary to shorten the focus by pushing in the eye-piece a little, in order to obtain a fair congruity of the eye-piece wire and the lines of the blue and violet part. This produces what may be called an *artificial or telescopic irrationality* of the spectrum, which destroys a little the accuracy of the relations of both its wings to each other in the metric conception. But if both wings are considered separately, all measurements lying between *a* and *b* on the one hand, and between *b* and the violet end on the other, are, with the best adjustment obtainable, accurate amongst themselves. For the rest, this source of relative error happily affects the principal points of the following observations very little, inasmuch as the phenomena to be discussed are mainly situated in the first or red end part of the spectrum.

We are thus enabled to attribute their actual and no exaggerated value to the following determinations:—

When the platinum wire of the eye-piece covered a line *X*, seen with the best adjustment obtainable for one-half of the spectrum, the point of the arrow on the indicator of nonius stood upon Y degrees Z minutes.

Single minutes could no longer be read. Two and three could be estimated. The constantly changing intensity of

the brightest sunlight produced slight variation in the readings, so did the inaccuracies of the heliostat. But ultimately the following measurements were assumed as determined:—

Red end of spectrum 143° . (Difficult and changeable.)

A $142^{\circ} 54'$

a $142^{\circ} 42'$

B $142^{\circ} 30'$

C $142^{\circ} 18'$

D $141^{\circ} 42'$

E $140^{\circ} 48'$

b $140^{\circ} 36'$

F 140°

G $138^{\circ} 24'$

H $136^{\circ} 54'$

H' $136^{\circ} 48'$

Violet end $136^{\circ} 18'$ (Most difficult to determine.)

Focus shortened; eye-piece pushed in.

By repeated observation it was found that the ends of the spectrum could not be absolutely determined within a fluctuation of $0^{\circ} 6'$. But the error never had wider limits. The same was ascertained to be the chance of error in the reading of the terminals of feeble absorption bands. "My readings might differ by $0^{\circ} 6'$ from each other, or the readings of my assistants might differ from my own by $0^{\circ} 6'$, but rarely or never more. But when the bands were dark and well defined, such as blood bands, or the bands of concentrated hæmatine solution, any number of readings made successively by myself or my assistants would always give the same results."

(To be continued.)

Water Analysis: a Practical Treatise on the Examination of Potable Water. By J. ALFRED WANKLYN, M.R.C.S., Professor of Chemistry in the London Institution, and ERNEST THEOPHON CHAPMAN. London: Trübner and Co. 1868.

The circumstances under which this little work appears, together with the importance of the controversy with which it is connected, render it our duty to examine it more carefully than we should otherwise have done—more carefully, indeed, than its inherent value deserves. The book is, in truth, little more than a description of the methods which the authors have proposed, and an elucidation of the results obtained by them; and these are already in the hands of every chemist. The accounts of the methods and reasonings of other chemists are for the most part meagre and imperfect, and an ill-natured reader will be apt to fancy that the book is chiefly written to enforce the simple doctrine that all that the authors have done is right, and all, or nearly all, that other people have done is wrong.

The introduction describes the method of collecting samples of a water, and indicates the necessity of observing its physical characteristics, such as colour and smell. Nothing, however, is said about the proper way of observing these important points, and the whole preliminary examination is dismissed in half a dozen lines. The authors do not even allude to the possible presence of sulphides in the water, or to their significance if found.

We may as well take this opportunity of remarking that not only is there no description of the mode of determining the dissolved gases of water, but that there is no allusion to this extremely important determination throughout the book.

Chapter I. is devoted to "Total Solid Residue." There is nothing particular to notice in it except that the authors recommend the evaporation of a smaller quantity (70 to 100 cubic centimetres) than is generally taken, that they follow Dr. Frankland in discarding the use of sodic carbonate, and that they dry the residue, after evaporation over the water-bath, at a temperature of 130° C. They also agree with Dr. Frankland in thinking the loss by burning an untrustworthy indication.

Chapter II. is on "Hardness." The details of the soap-test method are copied from Dr. Noad's "Quantitative Analysis," but we do not find any mention of the peculiar action of magnesium salts upon the soap-test, although the

subject was thoroughly investigated by Campbell, and a "magnesian-hardness" table constructed many years ago. The greater part of the chapter is devoted to a consideration of the soap-test indications. A distinction is very properly drawn between the test as an indication of the soap-destroying power of the water, and as an inferential indication of the quantity of earthy salts present. The preference is given to the former mode of interpreting the result, and the soap-destroying power of pure water is therefore added on the scale to that of the calcic carbonate in the standard solution. Thus, 16 grains of chalk dissolved in 1 gallon of water is called water of 17° H., 1 gallon of water being considered equal to 1 grain of chalk, and the strength of the soap solution is changed so that thirty-four measures are required to soften it. The soap-test measures are divided into half, and they then become a tolerably correct direct measure of the soap-destroying power of the water, for the higher numbers especially. It will occur to many of our readers that there is no substantial difference between this mode of interpreting soap-test indications and that formerly used, when the standard was thirty-four measures = 16° H., and when the hardness in the higher degrees was found by the formula—

$$H = \frac{n-2}{2},$$

n representing the number of soap-test measures required. This scale and formula are still employed by some chemists, and there are certain advantages attendant upon their use. The more modern scale is, as our readers are aware, 32 measures = 16° H., and the degrees of hardness above 16° are found by diluting the water before titration say to one half, halving the number of measures used, finding the hardness to which the half corresponds and doubling it. This formula is employed because the usual object has been to ascertain the chalk-equivalent present, and not the soap-destroying power of the water. It is curious to notice that some of the indications obtained by this formula are absurd—that 33 measures, for instance, only correspond to 14.95° H., while 32 measures correspond to 16° H. To apply it in determining the soap-destroying power of the water is evidently inaccurate, the object in this case being to ascertain the quantity of soap decomposed by the normal water, and not by the same water in a state of dilution.

Chapters III. and IV., on "Chlorine," and on "Nitrogen existing as Nitrates and Nitrites," need not detain us long. The modification of Schulze's aluminium process devised by Mr. Chapman (*Journal of the Chemical Society*, May, 1868), is adopted for nitrates and nitrites, and appears peculiarly suitable for the purpose. The only addition here made is an ingenious plan for determining, without distillation, the nitrogen present in these forms a plan which may often be found useful. Dr. Frankland and Mr. Armstrong's method is quoted entire, and is even treated with a certain measure of respect! But it is held to be inferior in all respects to that of Schulze. The chapter concludes with some reasoning against the notion that nitrates in potable water are always due to previous sewage contamination. The authors point to the water of chalk springs, which often contains much nitrates, and remark that the nitric acid in such cases, if it has been formed from sewage at all, can only have been formed from "fossil sewage, which was organic matter long ago in the geologic ages." Dr. Frankland's answer to this is that chalk beds form natural tanks for the reception of drainage water from the lands above, and that, therefore, the nitric acid is formed directly from sewage. The point must still be considered somewhat doubtful.

We now come to Chapter V., which is at once the longest and the most important in the book. It is entitled "Ammonia and Organic Matter," and is chiefly occupied by a description and development of the so-called ammonia method of examining water. Two or three pages are, indeed, devoted to other methods, but they are only slightly sketched, and are all condemned as untrustworthy. We are inclined

to think that chemists have been too hasty in discarding the burning and permanganate processes. It is quite possible, even now, that with suitable modifications and greater knowledge, their indications may be found of use. Dr. Frankland and Mr. Armstrong's elaborate and most elegant method is not even described in detail. The authors dismiss it with the following curt condemnation:—"We cannot recommend this process; it is very troublesome, and, in our opinion, very inaccurate." In the appendix they reprint from the *Journal of the Chemical Society*, their objections to it. It is noteworthy that they nowhere assert that they have tried it, but this omission they would probably justify by their disbelief in the possibility of eliminating nitric acid by the use of sulphurous acid.

The history of the simple and beautiful process which the authors, in conjunction with Mr. Smith, have devised, is not a little curious, and illustrates remarkably the danger of the over-hasty publication which has on more than one occasion been adopted by the chemists of the London Institution. We have no wish to be uncharitable, and should be sorry to ascribe this habit to a mere *insanabile scribendi cacoëthes*. It is no doubt due to an excess of scientific fervour, a sort of scientific *afflatus*, which forms a part of the unconscious poetry of these gentlemen's natures, and which impels them to burst forth in paeans at the Chemical Society whenever any one of them conceives a new idea. We may admire such gushing enthusiasm, but we cannot but regret that the scientific fame which these gentlemen are acquiring, and which is destined, we trust, to be lasting, should be sullied by the publication of raw, incomplete, and sometimes inaccurate results.

On the 18th of April, 1867, Messrs. Chapman and Smith read a short paper to the Chemical Society, in which they described the very curious reaction of alkaline potassic permanganate with alcohol and lactic acid. This appears to have suggested the trial of the same reagent as an aid to water analysis. Accordingly only two months later, on the 20th of June, appeared a second paper by the same authors, in conjunction with Professor Wanklyn. In this paper the ammonia process was first announced, and the method then suggested has been but little modified since. The authors have discarded the separate distillation with potassic hydrate, and have taken to using half a litre instead of a litre. In the present work they describe a method of determining ammonia directly in the water, without distillation, which appears to present some advantages. The rest of the process is too well known to require detailed description here. The ammonia is determined directly in the water, then a portion is distilled from sodic carbonate, and the ammonia in the distillate determined, and lastly alkaline potassic permanganate is added, a second distillation made, and the ammonia once more determined in the distillate.

So far, all is well. The process is ingenious and very simple, and if the theory first put forth were correct, would leave little to desire. But, unfortunately, the authors began with a broad theoretical statement which has by no means borne the test of subsequent verification. In the original paper, it was distinctly asserted that distillation with sodic carbonate would eliminate all the nitrogen of urea in the form of ammonia, that albumenoid bodies under these circumstances lost none of their nitrogen, and furthermore, that the same albumenoid bodies would yield all their nitrogen as ammonia when distilled with alkaline permanganate. These propositions, which claimed to be based upon experiment, were very soon called in question. On the 13th of September, Mr. Dugald Campbell read a paper before the British Association, in which he pointedly denied that such sharp distinctions could be drawn. He could not get all the nitrogen from urea in the way described, and found that albumen lost much of its ammonia during the distillation with sodic carbonate. On the 7th of November, Professor Wanklyn produced a "verification" of the process, which, to the amusement of the chemical world, turned out to be in many respects a confutation rather than a verification of the original paper.

His experiments with weighed quantities compelled him to admit that pure urea would not yield all its nitrogen, but only a very small part of it, when treated by the prescribed method, and furthermore, that albumen, instead of yielding the theoretical amount of ammonia during the permanganate distillation, only yielded a fraction of it, which, he said, "appears to be two-thirds of the total quantity, being at any rate a constant fraction of the total quantity." He got over the urea difficulty by asserting that, although pure urea was not decomposed under the circumstances, impure urea was; but as he added his pure urea to dilute white of egg, is pure urea, it is difficult to fancy what constitutes an impurity. In a still later paper, by Wanklyn and Chapman, a further experiment on albumen is recorded, in which 100 parts of dry albumen were found to yield "about" 10 parts of ammonia.

It is obvious that these experiments and admissions upset the lofty claims with which the process was first promulgated, and it is not surprising that Dr. Frankland, in his diligent search for absolute accuracy, should have rejected it. But it would be too much to assert that any experiments have yet demonstrated the process to be valueless. On the contrary, we are inclined to believe that from its simplicity and delicacy it is even now a very useful empirical method of judging of the quality of a water. It is, moreover, quite possible that when the conditions are better understood, a really trustworthy method, capable of giving absolute, and not merely relative results, may be founded upon its basis. This, however, can never be achieved by the mere multiplication of analyses of waters of unknown composition, but only by a vigorous scrutiny into the mode in which the reagents act. The authors of the new method must not imagine that chemists are prejudiced against it simply because they hesitate to accept evidence so inconclusive, and of such doubtful character—evidence, moreover, which is contradicted in important points by chemists of the greatest experience. They have only to persevere in the true path of scientific logic and the precise value of their method will soon become as clear as noonday.

We have no space to follow our authors in their criticism of Dr. Frankland and Mr. Armstrong's process. That, like the one we have been considering, awaits the verification of further experiment, and all attempts to decide on the respective merits of the two systems, except by the multiplication of researches, are sure to prove abortive. Whether the ammonia method be ultimately adopted by chemists or not, its authors are certainly entitled to the praise of having produced a very ingenious and promising process.

CORRESPONDENCE.

Gerhardtism.

To the Editor of the CHEMICAL NEWS.

SIR,—The depression of my spirits, consequent upon a compulsory return to the laboratory from a more highly ozonised region, has been greatly relieved by the perusal of your excellent journal of the 24th of July, from which I learn, with unspeakable pleasure, that one of our most distinguished chemists is exhibiting decided indications of recovery from Gerhardtism, from which he was one of the first to suffer on the outbreak of the disease in this country.

The distressing character of the attack may be inferred from the following extracts from that magnificent fragment, his "Manual of Chemistry" (Longmans, 1861).

At page 10, we find that "the essential character of an acid is its capability of exchanging hydrogen for a metal;" and again at page 11, that "an acid is a hydrogenised body, which, when treated with hydrate of potassium, can exchange hydrogen for potassium, with simultaneous formation of water."

Now, Sir, you will, I think, agree with me that we must hail the following as an unmistakable symptom of approaching convalescence:—"Further, in considering the properties of disulphide of carbon, we shall find that it acts as an *anhydrous acid*, combining directly with bases to form definite salts, strictly comparable with the ordinary carbonates produced by the *direct combination of carbonic acid with bases*."—(CHEMICAL NEWS, July 24, p. 41. *Am. Repr.*, Sept. 1868, page 134.)

The statement that liquefied carbonic acid gas is heavier than water, a line or two earlier, shows that the mind has not yet entirely recovered its admirable powers.—I am, &c.,

A. N. HYDRIDE.

Sulphocyanide of Ammonium.

To the Editor of the CHEMICAL NEWS.

SIR,—Being obliged to prefer an invigorating tour in Scotland to attendance at the Norwich Meeting of the British Association, I had not an opportunity of making remarks on a paper read before the Chemical Section by Dr. T. L. Phipson, F.C.S.

I am a good deal astonished at the fact stated by him of his having found some sulphate of ammonia of commerce to contain 75 per cent of sulphocyanide of ammonium. Some twenty years ago it was the custom to saturate the ammoniacal water of the gas manufacture with sulphuric acid, then to evaporate and crystallise. At that time the greater part of the sulphate of ammonia of commerce was contaminated with sulphocyanide; more recently, the almost invariable mode in use has been what is technically called blowing the sulphates—that is, blowing high pressure steam into the gas water, and conveying the vapours containing all the volatile compounds into sulphuric acid; sulphate of ammonia so produced contains no sulphocyanide, as that compound is not volatile. I am at this time operating upon a lot of 20 tons, from Glasgow, bought without any stipulation beyond its percentage of ammonia, and it does not contain the slightest trace of sulphocyanogen; I therefore conclude, that what Dr. Phipson found to contain 75 per cent of sulphocyanide must have been a very exceptional article.

The chief matters of scientific interest in Dr. Phipson's paper is the mode by which he separates the sulphocyanogen compound. It so happens that some three years ago I obtained provisional protection for a process for the manufacture of sulphocyanide of ammonium, of which Dr. Phipson's mode is in so far an exact reproduction, only he does not carry it out so as to complete it as a practical process.

I found the residual gas waters, after all the volatile compounds were blown off, to be rich in sulphocyanides; to this liquor concentrated, I added a mixed solution of protosulphate of iron and sulphate of copper; I had then a beautiful greyish-white precipitate of cupreous sulphocyanide. To obtain pure sulphocyanide of ammonium, as to which Dr. Phipson's paper in the report now before me gives no directions, I took advantage of the strong affinity of copper for sulphur. Sulphide of ammonium, however, as generally sold, is a dear and not a very pure compound; a strong solution of sulphate or chloride of ammonium was mixed up with soda waste fresh from the vats. Steam being blown into the mixture, there distilled off a strong and pure solution of NH_4S ; this being added to the wash precipitate of cupreous sulphocyanide, double decomposition took place, and I had pure sulphocyanide of ammonium in solution. Many hundredweights of this salt were made, and the process was perfect, but, unfortunately, the demand for the article was extremely limited, pounds of it only were wanted where tons had to be produced in order to make it a profitable manufacture, and I put the thing aside.

I can, however, corroborate Dr. Phipson as to the beauty of the crystals—they are of pure and dazzling whiteness,

and often radiate in length of 6 to 8 inches in the crystallising vessel.—I am, &c.,

Manchester, Aug. 31, 1868.

PETER SPENCE.

Sulphocyanide of Ammonium.

To the Editor of the CHEMICAL NEWS.

SIR,—The letter inserted in your last number (*Am. Repr.*, Nov. '68, page 272) calls for a word of reply, since it is evident that Mr. Spence had not then seen more than an imperfect report of the paper to which he alludes.

Doubtless many members of the British Association will feel, like myself, the loss we have sustained by his absence from Section B., when my paper was read, as this unfortunate circumstance deprived us of the very valuable remarks which he has since undertaken, a little hastily, perhaps, to lay before your readers.

Mr. Peter Spence is "a good deal astonished" that I should have found samples of commercial so-called "sulphate of ammonia," which were nearly all sulphocyanide, and thinks it must have been "a very exceptional article."

Perhaps he will be still more surprised when I inform him that it is not "an exceptional article," that samples representing many hundred tons of this particular product—I may state roughly some 800 to 1,000 tons perhaps—have been forwarded to my laboratory during the last five months by well-known houses in London and elsewhere. I thought it useful to call the attention of those interested in agriculture to the fact, that of this compound (valued by its nitrogen) only one-half the nitrogen is available for agricultural purposes.

Mr. Peter Spence thinks that "the chief matter of scientific interest in Dr. Phipson's paper is the mode by which he separates the sulphocyanogen compound."

I am sorry to differ from him in this respect. The portion of my paper which relates to the composition of the so-called sulphocyanogen, $C_4H_5N_3S_2O$, would appear, I doubt not, to any chemist, more important than that to which Mr. Spence alludes. However, in reply to his remarks, I wanted a method for estimating sulphocyanogen in a mixture of sulphate, chloride, and sulphocyanide of ammonium, and I found this method in the precipitation of the sulphocyanogen as a salt of copper, subsequently dried at 100° . The insolubility of this copper salt was known before Mr. Peter Spence was born, but I alone have shown that it can be used as an analytic method in the above circumstances. There was no allusion to any manufacturing preparation of sulphocyanide in my paper. The process which Mr. Spence mentions as having been patented by him, though somewhat ingenious, is far too costly. There is a very much more economical method for obtaining the whole of the sulphocyanide of ammonium from gas-liquor, well known in London if not in Manchester.

With regard to this subject I will trespass no more on your valuable space, since my paper, as read at the British Association, has now appeared in your columns, and, therefore, whatever may be said about it can easily be confirmed or refuted by referring to the paper itself.—I am, &c.,

T. L. PATERSON, Ph.D., F.C.S.

The Cedars, Putney, S. W., Sept. 8, 1868.

MISCELLANEOUS.

Carbolic Acid, a Cure for Snake Bites.—Messrs. F. C. Calvert and Co. have forwarded us a letter they have received from John W. Hood, B.Sc., M.D., of Melbourne, Australia, from which we make the following extract:—"An unfortunate experiment, resulting in the death of the principal performer, as to the efficacy of a so-called antidote for snake-bites, took place here some few weeks since, and of which I send you a report. The cure of persons bitten by the

venomous snakes of Victoria has long been a favourite subject for experiments among the medical profession here. I, living in the city, have not the opportunity of meeting with any human subjects to experimentalize upon, and have to rest contented with quadrupeds—most of which suffer death. However, I have long entertained the opinion that carbolic acid, taken internally and used as a caustic to the wound, would be found to be beneficial, and, perhaps, a specific cure. That I am right, to a certain extent, is proved by the fact that a friend of mine, a medical man living at Warrnambool, Dr. Boyd, successfully treated two cases of snake-bite with carbolic acid. I am not aware of more particulars than that the first case was a young lad bitten by a tiger-snake the most venomous these colonies produce, and Dr. Boyd—six hours after the boy was bitten—administered ten drops of pure acid, in brandy-and-water, every few minutes. He writes—"the effect was magical—from a pallid countenance, slow pulse, and semi-comatose condition, the patient rallied to a bright expression, ruddy glow, and quick pulse, and the recovery, though slow, was continuous and certain."

The Temper of Modern Science indirectly rules the progress of the healing art. It is of consequence to appreciate what that temper is. It would be difficult more aptly to describe it than by the words of Newton:—"The main business of natural philosophy is to argue from phenomena without feigning hypotheses, and to deduce causes from effects, till we come to the very first cause, which certainly is not mechanical." This phrase suggested to one a countless host of loving worshippers, to another a crowd of stern inquirers, each in his own sphere, tinged with the special hue of his own nature; in physics and biology all alike are searching for a true cause. From the causes of twining in the delicate tendril to the causes of variation in the human species, from the causes and local conditions of atmospheric changes, to the causes and physical consequences of the combustion of a fixed star, the biologists and astronomers of the day are seeking a true cause. And each in his way, appreciated by hundreds of fellow-workers and ten thousands of more or less intelligent followers, is making a step towards the first cause, which, Newton says, "is certainly not mechanical." And what have they reached? The generalisation, at once so simple, so overwhelming, that all action of which we are immediately cognisant is but the result of the operation of solar heat upon and through interdependent and correlative existences; that all things in this system are capable only of interchange; that there is no destruction of what exists, no creation of new energy.—*Dr. Acland. Inaugural Address before the British Medical Association, Aug. 4, 1868.*

The Fire at Newcastle.—**Journalistic Science.**—A correspondent has forwarded a Newcastle paper (purporting to be local, but in reality London, as most of it is sent down ready manufactured), giving a description of the very disastrous fire which took place at the Friar's Goose Chemical Works, on the 2nd inst. From the following extracts which we cut from this report, it may be questioned whether the time has come for ordinary journalists to write about and advocate "Technical Education," when they, as educated men, are so deficient in chemical knowledge as to write a description like this.—"The principle on which the different parts of the work was arranged, was, to give the acid chambers an exalted position, so that the material might be easily conveyed, by means of immense pipes, to the places where it was needed for further manufacturing processes. The operations were thus commenced with the production of sulphuric acid, at the greatest possible distance from the river, and were finished nearer to the river's edge, with the manufacture of products—soda, alkali, &c.—ready for shipment. This acid, which is the principal agent in the manufacture of soda and alkali, is produced by the burning of pyrites or sulphate. In these works only pyrites was employed, and it is imported from Spain. After the burning process, it is put into a furnace along with salt, and exposed to the heat of a fire underneath. The result of this process is to produce

sulphate of soda, which is, in its turn, converted into carbonate of soda, by being mixed with chalk and coals, and again exposed to a great heat. The furnaces which yielded this heat were principally under the acid chambers that have been destroyed. The product of the last-mentioned operation is turned into soda-ash or crystals of soda by means of a process of carbonating or crystallising. The flames leaped from one point to another until the whole of the roof covering this range succumbed to its devouring fury. Next to the acid chambers, the chief loss lay in the total destruction of four of Guy Lussack's towers to the west of the chambers. The erection of the towers themselves had been finished only lately. The lead had been got into them although the packing operations had not been quite completed. The object they were intended to serve was to recover the nitre and sulphuric acid processes."

British Association for the Advancement of Science (Norwich Meeting).—At the concluding meetings the following recommendations were adopted:—

"That the committee on luminous meteors and aërolites, consisting of Mr. Glaisher, Mr. R. P. Greg, Mr. E. W. Brayley, Mr. Alexander Herschel, and Mr. C. Brooke, be re-appointed; Mr. Herschel to be Secretary.

"That the committee consisting of Dr. Tyndall, Dr. Lyon Playfair, Dr. Odling, Rev. C. Pritchard, Professor Kelland, Professor W. A. Miller, and Professor Foster, be re-appointed for the purpose of enquiring into the present methods of teaching the elements of dynamics, experimental physics, and chemistry in schools of various classes, and of suggesting the best means of promoting this object in accordance with the recommendations of the report of the committee appointed by the Council; and that Professor Foster and Dr. Odling be the Secretaries.

"That Lieut.-Col. Strange, Professors Sir William Thompson, Tyndall, and Franklyn, Dr. Stenhouse, Dr. Mann, Mr. Huggins, Mr. Glaisher, Professors Williamson, Stokes, Fleming Jenkin, Hirst, Huxley, and Dr. Balfour Stewart, be a committee for the purpose of inquiring into, and of reporting to the British Association, the opinion at which they may arrive concerning the following questions:—1. Does there exist in the United Kingdom of Great Britain and Ireland sufficient provision for the vigorous prosecution of physical research? 2. If not, what further provision is needed, and what measures should be taken to secure it? That Dr. Robert James Mann be the Secretary."

Mr. Griffiths made the following statement of the number of tickets which had been issued at the Norwich Meeting:—196 old life, 18 new life members, 226 old annual, 117 new annual, 720 associates; 682 ladies, and 45 foreign members and their ladies; total 2,004.

Sir James Y. Simpson on Medical Progress.—At the close of the ceremony of "capping" the medical graduates of the University of Edinburgh, on Saturday, Sir James Simpson delivered an address. In the course of his remarks, he said:—"A most extensive field for new investigations lies temptingly open for the young and ambitious physician in the almost innumerable series of new chemical compounds which modern organic chemistry has evolved. Among this world of new compounds will probably be yet detected therapeutic agents more direct, more swift, and yet more sure in their action than any which our present pharmacopœias can boast of. It may be, also, that the day will yet come when our patients will be asked to breathe or inspire most of their drugs instead of swallowing them; or at least when they will be changed into pleasant beverages instead of disgusting draughts and powders, boluses, and pills. But that day of revolution will not probably be fully realised till those distant days when physicians—a century or two hence—shall be familiar with the chemistry of most diseases; when they shall know the exact organic poisons that produce them, with all their exact antidotes and eliminators; when they shall look upon the cure of some maladies as simply a series of chemical problems and formulæ; when

they shall melt down all calculi, necrosed bones, &c., chemically, and not remove them by surgical operations; when the bleeding in amputations and other wounds shall be stemmed, not by septic ligatures or stupid needles, but by the simple application of hæmostatic gases or washes; when the few wounds then required in surgery shall all be swiftly and immediately healed by the first intention; when medical men shall be able to stay the ravages of tubercle, blot out fevers and inflammations, avert and melt down morbid growths, cure cancer, destroy all morbid organic germs and ferments, annul the deadly influences of malaria and contagions, and by these and various other means markedly lengthen out the average duration of human life; when our hygienic condition and laws shall have been changed by State legislation, so as to forbid all communicable diseases from being communicated, and remove all causes of sickness that are removable; when the rapidly increasing length of human life shall begin to fulfil that ancient prophecy, 'the child shall die an hundred years old';—when there shall have been achieved, too, advances in other walks of life far beyond our present state of progress; when houses shall be built and many other kinds of work performed by machinery, and not by human hands alone; when the crops in these islands shall be increased five or ten fold, an abundance of human food be provided for our increased population by our fields being irrigated by that waste organic refuse of our towns which we now recklessly run off into our rivers and seas; when man shall have invented means of calling down rain at will; when he shall have gained cheaper and better motive powers than steam; when he shall travel from continent to continent by submarine railways, or by flying and ballooning through the air; and when—to venture on only one illustration more—tiresome graduation addresses shall no longer require to be written by old professors nor listened to by young physicians."

The Alkaline Deposits of Western America.—The correspondent of the *Chicago Tribune* writes as follows of the country west of Laramie, on the Pacific Railroad:—

"From Laramie to here the country is very miserable and very curious. Here and there a patch of buffalo grass may be seen, but rarely anything except sage brush and cactus. The ground seems incapable of producing anything else. The banks of all the small streams glisten with white where the alkali has been evaporated. Almost all the small streams here are impregnated with this alkali. It renders the water almost useless for all practical purposes, but it produces some very queer effects, as the workmen on the road and the visitors can testify. If one drinks much of it, the same effect is produced as if a strong dose of salts is taken. This greatly disgusted the workmen when they were forced to drink it. Nor can the water be used in the engines with any effect; the steam it makes has no power. The water expends itself in froth and suds, and it eats and corrodes the boiler. This has been a great source of annoyance, and is one of the worst obstacles that the road has to overcome. Another peculiarity of this water is the effect it produces on the skin of those who wash in it; it roughens the skin of the hands just as a cold wind chaps it in winter. It also peels the skin from the face, so that a person who uses this water has a new skin about every seven days. This is especially the case where soap is used in washing. The graders west of here, where the alkali in the water is much stronger, say that when soap is wanted for washing clothes, &c., they put some grease in the alkali water, stir it up with a stick, and there is soap. Naturally it costs but little, and when freights are reduced on the road it is proposed to supply the whole United States with cheap and good soap. Unfortunately there is no demand for that article among the Indians, and the Great Western Soap Factory cannot be started at present. As it is, every man is his own soap-maker. The result of this bad water has been to force the railroad company to dig deep wells along the line of this road. But even this is not always satis-

factory; the well at Wyoming, fifteen miles west of Laramie, is almost useless on account of the alkali. In some places along the road the country is almost completely covered with the low thick sage brush, useless for anything, except in some places where the wood is so large that it can be burned. In this region, where the land happens to be free from the sage brush, it is often so impregnated with the alkali that for two or three inches down the earth crumbles and sinks beneath the feet like ashes. Every now and then there are found in this region drifts of fossils of fish, oysters, clams, &c., thrown up from the bottom of the sea quite a time ago. Some of these fish are so well preserved that the glitter of the gold and silver on their scales is almost as bright as ever. The oysters and clams are tremendous in size, and would well do for the giants of the olden days. Some of the snakes are quite large in size, but few of them are perfect. Some of them are found embedded in red sandstone, while others lie loose in the earth. Along with these are to be found many sea shells of various kinds. In some cases the fish will be found split open, and all the bones perfectly preserved. Some of these drifts are on the tops of bluffs, while others are low down.

PATENTS.

Communicated by Mr. VAUGHAN, F.C.S., Patent Agent, 54, Chancery Lane, W. C.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

2428. J. Scott, Sheffield, "Improvements in the preparation of food for horses, cattle, and other animals."—Petition recorded August 1, 1868.
2429. F. Walton, Staines, Middlesex, "Improvements in the treatment of resins or resinous gums, and in the application of the products obtained therefrom."—August 8, 1868.
2511. D. Hill, J. Richardson, Stockton-on-Tees, Durham, G. N. Duck, Coatham, near Redcar, Yorkshire, C. G. Johnson, Stockton-on-Tees, and W. F. Masterman, Aislaby Hall, near Whitby, Yorkshire, "Improvements in the manufacture of iron and steel."
2514. J. Thompson, Handsworth, Staffordshire, "Improvements in reducing and utilising certain descriptions of scrap homogeneous iron or steel."
2515. J. Broad, Arthur Street West, London, "Improvements in machinery, apparatus, and process in the treatment of carboniferous plants and other fibrous material for the manufacture of paper, cardboard, and other similar articles."
2517. C. D. J. Seitz, Bury, Lancashire, "Improvements in the construction of furnaces for the recovery of the soda from the waste lyes resulting from the boiling of esparto grass or straw in the working and incineration of the residue resulting from evaporation, and in an improved means of depriving it of any offensive odour."
2529. R. Sim, M.D., Naples, "Improvements in compositions for preventing the fouling of ships' bottoms and other buildings exposed to the action of sea or impure water."—August 12, 1868.
2540. H. K. York, Cardiff, "Improvements in treating cast iron and other metals, and in apparatus employed therein."—August 13, 1868.
2541. H. B. Binko, Kingsland, Middlesex, "Improvements in the treatment and preparation of indigo for laundry and other like purposes."
2542. W. Shoen, Bedford Row, Middlesex, "Improvements in the manufacture of explosive compounds."—A communication from J. F. E. Schultze, Potsdam, Prussia.
2545. J. B. Thompson, Horton, near Slough, Bucks, "Improvements in coating iron and steel with gold, silver, and copper, and in apparatus for carrying out the same."—August 14, 1868.
2548. O. D. Abel, Southampton Buildings, Chancery Lane, "Improvements in the production of brown colouring matters for dyeing and printing."—A communication from J. G. A. Gros, Mulhouse, Haut Rhin, France.
2556. A. M. Clark, Chancery Lane, "Improvements in the manufacture of size."—A communication from T. Gray, Boulevard St. Martin, Paris.
2558. W. B. Espeut, Jamaica, "Improvements in curing, drying, and extracting molasses from sugar and other substances, and in apparatus employed therein."—August 15, 1868.
2560. A. Smith, Glasgow, N. B., "Improvements in the manufacture of sugar, and in apparatus therefor."—A communication from K. Smith, Demerara.—August 17, 1868.
2017. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the production of a red colour for dyeing and printing."—A communication from L. Durand, Bale, Switzerland.—Petition recorded June 22, 1862.
2492. F. Le Roy, Commercial Road, Middlesex, "An improved

non-conducting composition for preventing the radiation or transmission of heat or cold, and an improved method of applying the same."—August 20, 1868.

2561. E. Beanes, Cordwallis, near Maidenhead, Berkshire, "Improvements in the manufacture of brewers' filings."
2562. B. Hunt, Serle Street, Lincoln's Inn, Middlesex, "Improvements in the mode of decomposing the sulphurets of iron contained in ores, coal, coke, and other mineral products, and in apparatus therefor."—A communication from E. Granddiler, and M. Lue, Paris.—August 17, 1868.
2583. F. Braby, Camberwell, Surrey, "Improvements in treating and utilising waste sulphate of iron solution, arising from the cleansing of iron surfaces, and in the manufacture of tin plates."
2589. A. Clark, Chancery Lane, "An improved compound for tanning leather."—A communication from L. H. Dennis and O. E. Brown, Stafford Springs, Tolland, Conn., U.S.A.—August 19, 1868.
2600. H. O. Ensell, St. Helens, Lancashire, "Improvements in smelting copper and other metals, and in furnaces for smelting copper and other metals, and for other purposes, and in obtaining products from the gases and vapours given off during the smelting of copper and other metals."—August 20, 1868.
2617. J. Watson, Sunderland, Durham, "Improvements in blast furnaces, and in obtaining a hot blast for the same."—August 22, 1868.
2629. O. C. Setchell, Commercial Road, Surrey, "An improved composition applicable to the manufacture of bricks, artificial stone, and various articles capable of being moulded or pressed into form."—August 24, 1868.
2647. A. E. Borgen, Seething Lane, London, "A process for the direct decomposition of neutral fatty substances for the manufacture of stearine."—A communication from J. C. A. Bock, Copenhagen, Denmark.—August 25, 1868.

NOTICES TO PROCEED.

1210. G. Clark, Northumberland Street, Strand, Middlesex, "Improvements in the manufacture and production of explosive compounds, and in apparatus for their manufacture and use."—Petition recorded April 11, 1868.
1240. R. Oxland, Compton Gifford, Plymouth, "Improvements in the treatment of ores and minerals containing copper, to extract copper therefrom."—April 15, 1868.
1251. J. Robinson, Deptford, Kent, "Improvements in the manufacture of paint."—April 16, 1868.
1341. J. Baggs, High Holborn, Middlesex, "Improvements in the manufacture of white lead, and in the use and application of certain machinery and apparatus for such purposes."—April 24, 1868.
1513. C. E. Brooman, Fleet Street, London, "Improvements in preparing zirconia, and the employment of the same to develop the light of oxyhydrogen flame."—A communication from C. T. du Motay and Co., Paris, France.—May 8, 1868.
2376. W. R. Lake, Southampton Buildings, Chancery Lane, "An improved compound to be used as a substitute for linseed oil in the preparation of paint and varnish."—A communication from R. E. Ferguson and B. E. Ferguson, Chicago, Illinois, U.S.A.—July 29, 1868.
1283. W. Malam, Old Kent Road, Surrey, "Improvements in the manufacture of gas, and in apparatus employed in such manufacture, part of the invention being also applicable to the manufacture of retorts, retort casings, crucibles, and melting pots for various useful purposes."—Petition recorded April 20, 1868.
1361. P. Spence, Newton Heath, Manchester, "Improvements applicable to the purification of gas used for illumination."—April 25, 1868.
1382. E. McDonnell, Fareham, Hampshire, "An impervious concrete or cement."
1388. A. Dietz, New York, U.S.A., "An improved method or process of treating or preparing and refining glue."—April 28, 1868.
1397. W. Wright, Mostyn, Flintshire, "Improvements in the manufacture of iron-steel."—April 29, 1868.
1424. C. D. Abel, Southampton Buildings, Chancery Lane, "The production of a new or improved colouring matter from aniline."—A communication from B. Bloch, New York, U.S.A.—May 1, 1868.
1516. J. A. Jones, Middlesborough, Yorkshire, "Improvements in the manufacture of iron and steel."—May 8, 1868.
2428. J. Scott, Sheffield, "Improvements in the preparation of food for horses, cattle, and other animals."—August 1, 1868.

NOTES AND QUERIES.

Picrate of Quinine.—Can any of your correspondents inform me if the above has been experimented upon, and if it is of practical use?—BERNE.

Embalming.—Your correspondent, "A Physician," will find the different embalming processes described in Garna's "*Histoire des Embaumements et des Preparations des Pieces d'Anatomie.*" 8vo. Paris, 1838.

Rusting of Iron.—I should be obliged if any of your numerous subscribers would, through the medium of your valuable "Notes and Queries," inform me of a preparation which will prevent wrought iron from rusting, and at the same time be proof against attack of boiling caustic soda.—ENGINEER.

[Iron is almost completely preserved from rusting in the presence of caustic alkali.—ED. C. N.]

Stearic.—Can any of your readers tell me the chief uses and market price of stearic (soapstone)?—W. T.

Testing Oak Bark, &c.—What is the best means of testing oak

bark, valonia, &c., with a view to ascertain their relative value?—A. F. W.

Chemical Cement.—Can any of your readers tell me of a good cement that will resist the action of oil of vitriol, 175°? It is required to make the joints of a slate saturating cistern and drain for manufacture of sulphate of ammonia?—ROBIN.

Bleaching and Dyeing Cotton.—A SUBSCRIBER in Clinton, Mass., U.S.A., wishes to enquire through our "Notes and Queries" for some practical method of bleaching cotton yarn in the cop, and also for the best receipt for dyeing a handsome "fast" green on cotton yarn.

Fireproof Dresses.—Can any of your correspondents give me sufficient practical instructions to enable me to promote the use of fireproof dresses, especially on the stage. I think if I could show the dancers that the matter could be easily and cheaply accomplished, without injury to the fabric or discolourment to its beauty, many might be induced to adopt means to secure themselves and the theatre from danger, and the public from irritating fears. Careful details will be required; also some hints as to price, with the best mode and place for procuring the chemicals?—PHILIP SANKEY.

Second-hand Philosophical Apparatus.—Nindex can obtain second-hand philosophical apparatus, &c., at Mr. Stevens's Auction Rooms, King Street, Covent Garden. He must apply at the office for day of sale and catalogue.—S. P.

Testing Oak Bark, &c.—Various processes are in use for this purpose, but none can be well and fully described in the columns of "Notes and Queries," owing to becoming too lengthy for these. There are to be noted the methods of Fehling, Müller, Fraas, Hammer, H. Fleck, E. Wolff, H. Handke, Monier and Wagner, all of which are fully described in volume five of Wagner's *Hand und Lehrbuch der Technologie*, published by Otto Wigand at Leipzig.

Separation of Alumina and Sesquioxide of Iron.—Neutralise the very dilute solution of these two bases with carbonate of soda, then add hyposulphite of soda, and, finally, heat till no more sulphurous acid is disengaged. In this manner all the alumina collects together into a precipitate, which should be calcined. The iron remains in the liquor, which should be concentrated and then decomposed with chloride of potash and hydrochloric acid. After a filtration to remove sulphur, precipitate the sesquioxide of iron by ammonia.—F. WÖHLER.

Steatite is a mineral of the magnesians family; it has a greyish-white or greenish-white colour, a dull or fatty lustre, a coarse splintery fracture with translucent edges, is soft, easily cut with a knife, but somewhat tough, does not adhere to the tongue, feels very greasy, and is infusible before the blowpipe. Specific gravity from 2.6 to 2.8. It is used in the manufacture of porcelain; it is also employed for polishing serpentine, marble, and glass; is sold under the name of French chalk when in powdered state; it is also used for making gas burners. Chemical composition: silica, 62.14, magnesia, 32.92, water, 4.94. It is also used to remove stains of grease and oil from silk and woollen materials, and enters into the composition of certain crayons.—B.

Chemical Cement.—Jeffery's marine glue will answer the purpose. In this case, or, perhaps better yet, a caoutchouc cement obtainable by melting carefully India-rubber, taking care to stir well during the melting process, at the same time dry fire clay is added, from 6 to 8 per cent of the weight of caoutchouc, while at last, in order to give proper consistency, slaked lime is incorporated with the mass. This cement stands the action of boiling sulphuric acid. It may perhaps not be out of place to mention here the zedofelli, made up of nineteen parts of sulphur and forty-two parts of powdered glass or porcelain; the sulphur is molten, and the powder aluded to at the same time, heated to rather a oven the melting point of sulphur, and is then added to the latter, while the mixture is continually stirred; it is then cast in blocks and used, of course after heating again, for various purposes as cement, &c.—Dr. A. A.

Gallipot Oil.—Your correspondent "S. P." must be labouring under a mistake to suppose that Gallipot (originally), or magma oil, as it is generally termed, recovered from staldy or woollen waste by heat and pressure (after which it is clarified by boiling in a little SO₃), can again be refined by simple exposure to light and air. This process, I believe, is successful in its original state, but not after being used by woollen manufacturers in the production of cloth; no amount of exposure or filtration through charcoal can effect the object in view, without first precipitating the colours by some chemical means, as the colours with which it is impregnated are not removable by most of the chemical means generally adopted for refining other oils. Hence the necessity of distilling this so-called magma oil, for the purpose of bringing it to its original colour. I shall feel obliged to any of your learned correspondents who can give me the necessary information.—A. B. KENNICOTT.

Peaty Soil.—A Novice in Agricultural Chemistry speaks of the small crops obtained from some recently-drained peat land, and is surprised at the result, as the soil must necessarily have been very rich in humus. He asks—What exhaustion has produced this sterility? In the first place, the fertility of soils is by no means associated with the presence of humus. Soils may be exceedingly fertile which contain a mere trace of carbonaceous matter, while others rich in such materials produce scanty crops. In the next place, sterility is not always to be attributed to an absolute lack of the elements of plant food, but rather to the fact that they exist in a condition unsuitable for assimilation. With regard to the case mentioned, the soil, being mainly composed of peat, will certainly be very rich in nitrogen, and will probably be tolerably well provided with the other essentials of plant food. If the land has been well drained, much has been done to render these food constituents available for the production of crops; a good dressing of lime will also aid effectually towards the same end, and is probably, under the present circumstances, the best manure that can be applied to the land.—K. W.

ANSWERS TO CORRESPONDENTS.

NOTICE.—The American Publishers of THE CHEMICAL NEWS give notice that in accordance with a suggestion of Mr. CROOKES, the Editor and Proprietor of the English publication, they will be pleased to receive and forward to him in London any scientific publications issued in America, for review—and also any Notes and Queries, Articles, Correspondence, &c., for publication or reply. Their facilities of communication with Mr. CROOKES render this very desirable to all persons in the United States who wish to confer with him. Address,

W. A. TOWNSEND & ADAMS,
434 Broome Street, New York.

* * It is our pleasing duty to accord our best thanks to those gentlemen who have so kindly acceded to our request in sending us the necessary information respecting the Chemical and Medical Schools for our Students' Number.

Several correspondents have enquired where they can obtain the lamp referred to in our article "On the Measurement of the Luminous Intensity of Light." We have pleasure in informing them that Messrs. Johnson and Matthey, Metallurgists, of Hatton Garden, are making them, and will shortly have them ready.

Thema.—Dr. Hofmann's "Exhibition Report" can only be procured second-hand; copies are very scarce.

A Young Chemist.—To find out the composition of the substance sent would require a careful chemical analysis.

O. P. X.—Fluoride of ammonium and hydrofluoric acid are identical. It is very difficult to obtain this salt quite pure. A mixture of fluor spar and sulphuric acid is generally employed for engraving and etching glass. The dull engraving is effected by exposing the glass to the vapour of hydrofluoric acid, whilst the bright engraving is produced by applying the liquid acid. A mixture of wax and a little turpentine is used to coat the glass.

G. Dickens.—Please repeat the question, we do not understand what you refer to when asking for "the publisher's name of the manufacturing chemists and the description of goods they make."

J. L. Paines.—The substance contains sulphur and barium, but how combine we cannot say without performing a full analysis.

An Aspirant.—You want a more elementary book than the one you name. Roscoe's "Chemistry" would be more suitable.

F. J. B.—See above answer.

Subscriber.—We do not know the composition of "the liquid called ethyl." Probably it is a trade name. If you require it in large quantities an advertisement to that effect would be most likely to give you information.

T. D. Reed (Montreal).—Our publisher informs us that *Le Technologiste* for June, 1867, can be obtained separately.

T. B.—The pamphlet is out of print. An Introduction to Chemical Philosophy, by Adolphe Wariz F.R.S., will give you the information you require. It can be obtained at our office, price 3s. 6d.

Communications have been received from Rev. B. W. Gibbons, M.A.; Nicholson, Maule, and Co.; Mothershead and Co.; P. Holland (with enclosure); J. Parnell; Capt. W. A. Ross, R.A. (with enclosure); W. Schofield; J. T. Hoagles (with enclosure); P. Squire; Professor Heaton; Professor Bloxam; Dr. T. L. Phipson (with enclosure); Professor Wanklyn; W. H. Perkin, F.R.S.; E. Beanes (with enclosure); D. Kemp (Bombay); W. B. Davis (with enclosure); Townsend and Adams (with enclosure); W. Hunter (with enclosure); G. W. Keyworth; J. Levinstein (with enclosure); F. C. Calvert and Co.; P. Spence (with enclosure); Magnesium Metal Co.; Dr. Horace Dobell (with enclosure); C. Tomlinson, F.R.S.; P. Sankey; Dr. Kellner; A. P. Williamson; Dr. T. L. Phipson (with enclosure); L. Mone (with enclosure); G. Dickens; Otto Richter (with enclosure); T. A. Readwin; J. Paines; J. Bowing; C. E. Robinson; G. W. Weeks; E. Kernan; A. H. Allen (with enclosure); J. and W. Rickard; Dr. Dobell; B. Wheeler (with enclosure); R. Spice, Jun. (with enclosure); E. Beanes; J. Spiller (with enclosure); C. Blake; F. A. Abel, F.R.S. (with enclosure); R. Oertling; Dr. Russell; Dr. Rohrig; Dr. Struthers; Rev. B. W. Gibbons, M.A.; Professor Wanklyn; J. H. Pepper; Professor Church, M.A.; E. Smith; Dr. Muspratt; and Dr. Atfield (with enclosure); W. F. Barrett; Dr. Penny; P. Holland; L. Oertling; Rev. B. W. Gibbons, M.A. (with enclosure); The Jarrold Chemical Co. (with enclosure); C. S. Romain; E. Rowden; W. Schofield; R. J. Williams (with enclosure); G. W. Robinson; F. S. Hilliot; Dr. Apjohn; E. Brembridge; Brooke, Simpson, and Spiller; A. T. Brook (Michigan); W. Webb; Professor F. H. Storer, Boston, U.S.; S. M. Buck; Lawson Ltd.; J. W. Slater; B. H. Rogers, Victoria, Australia; O. Richter; Professor Heaton; W. M. Bowron; C. Lowe (with enclosure); Professor Living; J. Mayer; Dr. Moffatt; Dr. Sheridan Muspratt; J. A. Wanklyn; Messrs. Johnson and Matthey; J. Wallace Young (with enclosure); D. Forbes, F.R.S. (with enclosure); B. H. Rogers; C. M. Tidy; S. A. Sadler; W. Little (with enclosure); T. J. Shuster; E. B. Cow; Hill and Cox (with enclosure); and Dr. A. Adian.

Books received.—"Elementary Treatise on Physics, Experimental and Applied" Translated and edited from Ganot's *Elements de Physique*, 3rd edition, revised and enlarged. By E. Atkinson, Ph.D., F.R.S. London: Longmans. "Esposizione di Saggi dell'Industria Nazionale Italiana." Per G. Arnaud. "Del Legni di Amaro." Per G. Arnaud. "E. Sue Applicazioni nell'Industria." Per G. Arnaud.

THE CHEMICAL NEWS.

Vol. III. No. 6. American Reprint.

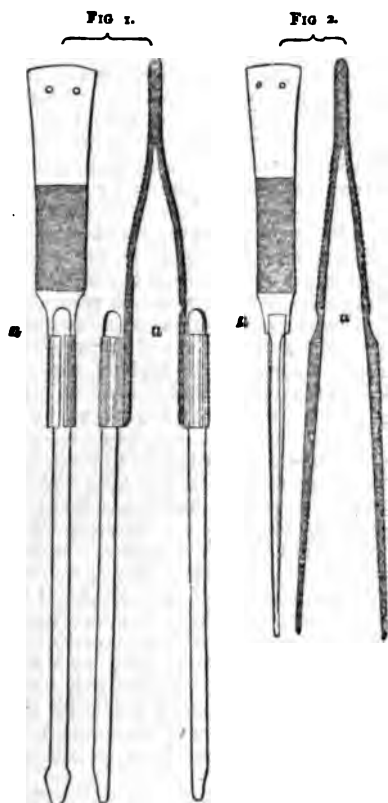
GLASS AND PLATINUM FORCEPS FOR MANIPULATING IN ACID AND OTHER SOLUTIONS.

BY DAVID FORBES, F.R.S. &C.

In the last number of the *Zeitschrift für Analytische Chemie*, 1868, vol. vii. p. 224, a description is given of a pair of tongs with glass extremities, invented by Dr. Muck, and intended for manipulating in acid solutions.

The construction of this piece of apparatus seems excellent, especially when a somewhat large and strong instrument is demanded; for more delicate purposes, however, as in analytical operations, the forceps now about to be described was devised a considerable time back, and has been found extremely useful in my laboratory.

The accompanying woodcut, Fig. 1, shows these latter in front and side view, and will require but little explanation. They were made as follows:—An ordi-



nary pair of strong surgical forceps were taken and the points cut off; a small piece of sheet brass, bent into a cylinder, was then soldered to each arm as shown at *a*; these cylinders being formed by merely bending the brass round so as to leave an open slit about one-twentieth of an inch wide in front. Two glass rods, such as are used for stirrers, as long as the glass arms of

the forceps were intended to be, and just as thick as would enter these brass cylinders when pressed with some force, were rounded by the blowpipe at the one end, whilst the other, when softened, were somewhat flattened between the glassblowers' pliers, as seen in the woodcut. In order to complete the forceps it was now only necessary to push each of these rods into its corresponding brass cylinder or socket, the longitudinal slits of which, by imparting a certain amount of elasticity to the sockets, cause them to grasp the glass rods firmly, and retain them without any cement or other fixing. The relative lengths of the arms are easily adjusted by slipping one rod more or less forward, whilst the points can be made to hold and meet accurately by rubbing them down on a piece of sandstone.

Such forceps may, of course, be made to any convenient size; the one figured in woodcut is drawn to exactly half size, and was found to be of very useful dimensions for general analytical work, especially when manipulating in nitrohydrochloric acid, nitrate of silver, and other solutions which would have acted upon metals, horn, ivory, &c.

Fig. 2 represents another convenient form of forceps, also drawn to one half the real size, with long platinum points soldered to the steel body at *a*; these have been also found of great service in general laboratory operations; especially when hydrofluoric acid is in question. They were made by Oertling, and the construction is so evident from the annexed woodcut as to require no further description.

RECENT ANALYSIS

OF THE

WATER OF THE "OLD SULPHUR WELL"

(ROYAL PUMP ROOM)

AT HARROGATE.

BY DR. SHERIDAN MUSPRATT, M.D. (HON.), PH.D., F.R.S.E., &C.

FOUNDER AND PRINCIPAL OF THE COLLEGE OF CHEMISTRY, LIVERPOOL.

FINDING singular changes in composition were going on in the spring at this fashionable watering place, I have from time to time during the last seven years analysed its several spas. It is now acknowledged that Harrogate stands at the head of British watering places, both on account of the variety and efficacy of its mineral springs, the beauty of its locality, and the salubrity of its air. Dr. Myrtle in his admirable work recently published, "Practical Observations on Harrogate Waters," remarks, "Patients return regularly, year after year, for twenty, thirty—aye, forty years; I know cases that never miss their three or four weeks of Harrogate water;" and the late Dr. Kennion wrote:—"Since the discovery of the chloride of iron water or 'Dr. Muspratt's chalybeate,' the place is more resorted to than ever, for this remarkable spring is without a prototype."

Annexed is the tabulated composition deduced from the new results:—

	Grains in the Imperial Gallon.
Carbonate of lime	10'545
Carbonate of magnesia	2'864
Chloride of sodium	862'412
Chloride of potassium	69'897
Chloride of magnesium	61'769
Chloride of calcium	79'878

Grains in the Imperial Gallon.	
Chloride of barium.....	4'998
Chloride of strontium.....	} mere traces.
Chloride of lithium.....	
Sulphide of sodium.....	16'418
Iodides, bromides, ammonia, &c.....	mere traces.

Cubic inches of carbonic acid in the gallon..	1108'781
Cubic inches of sulphide of hydrogen "	25'55
	7'01

This water, which emanates from a peat bog, is perfectly transparent as it issues to the light, and smells strongly of sulphide of hydrogen with which it is impregnated, and is naturally most saline to the taste, owing to the very large quantity of chloride of sodium which it holds in solution. Since my friend Dr. Hofmann's analysis in 1854, the water has parted with its very small amount of sulphate of lime, and acquired considerable quantities of carbonate of magnesia, chloride of barium, &c. Several of its active constituents (sulphide of sodium, chloride of potassium, magnesium), are augmented. Its total solid contents are increased *twelve grains* in the gallon. As regards its stimulating, aperient, solvent, alterative, and other effects, they are so well known, especially in hepatic diseases, as to need no further recommendation or observation.

College of Chemistry, Liverpool,
September, 1868.

ON SUSSEXITE,

A NEW BORATE FROM MINE HILL, FRANKLIN FURNACE,
SUSSEX COUNTY, NEW JERSEY.

BY GEORGE J. BRUSH.

In examining a specimen of a fibrous mineral, obtained at Mine Hill last year, I found that it was a fibrous silicate of zinc, and being desirous of further investigating the mineral, I requested my assistant, Mr. Wm. G. Mixer, on his recent visit to the locality, to obtain as much of the fibrous substance as possible, so that a quantitative analysis might be made of it. Mr. Mixer was fortunate in obtaining one specimen of what we at first sight took to be the fibrous silicate, but on examination of its pyrognostic characters it proved to be a new mineral, a hydrous fusible borate, reacting strongly with the fluxes for manganese. This interesting discovery led me at once to revisit the locality, and I there succeeded in obtaining enough of the new mineral to give the following characters. It is found in the franklinite vein at the opening on the north end of Mine Hill, associated with franklinite, zincite, willemitte, tephroite, calcite, and what appears to be a double carbonate of manganese and magnesia occurring, implanted on, or imbedded in the fibrous mineral in minute hemispherical forms; it has also associated with it a black hydrate of manganese, apparently the species manganite, and a pale pink carbonate, which is probably rhodochrosite. The black manganite and the double carbonate have the appearance of being products of the alteration of the borate, since where associated with these the latter seems exceedingly friable and evidently in process of decomposition.

The pure mineral is whitish with a tinge of yellow or pink, is translucent on the edges and in thin fragments, and possesses a silky to pearly lustre. The structure is fibrous, sometimes asbestiform, although in other specimens it seems to cleave much more readily in one direction than in a direction at right angles to this, yielding flat fibrous fragments. The mineral occurs in

seams in calcite, sometimes with the fibres running transversely, and in other specimens quite long and parallel to the seam. The hardness is slightly above 3, scratching calcite, but not arragonite. Specific gravity = 3'42.

On heating in the closed tube the mineral darkens slightly in colour, and yields water which reacts neutral to test-papers; but if turmeric paper is moistened with this water, then with a drop of dilute chlorhydric acid, and afterwards dried, it assumes the red colour, characteristic of boric acid, and thus shows that at least a trace of this acid is driven off with the water. In the forceps the mineral fuses in the flame of a candle (F. = 2), and B.B. in O.F. yields a black crystalline mass; on colours the flame intensely yellowish-green. With borax and salt of phosphorus gives a deep amethystine bead in O.F., which in R. F. become colourless and transparent. With soda yields a green manganate.

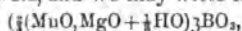
It is readily dissolved in chlorhydric acid, and most specimens thus treated give off a minute quantity of chlorine, showing traces of a slight alteration of the protoxide of manganese into a higher oxide. On evaporation to dryness and resolution in acid, minute imponderable traces of silica were found. Qualitative analysis proved the presence of boric acid, manganese, magnesia, and water, with questionable traces of zinc and soda. A fragment of the mineral moistened with sulphuric acid and held in the flame of an ordinary Bunsen burner, gave, when observed through the spectroscope, the characteristic spectrum of boric acid.

The exceedingly simple composition of the mineral rendered the quantitative determination of the bases comparatively easy. The mineral being dissolved in chlorhydric acid, the excess of acid was driven off, and the manganese was thrown down by bromine in the presence of an excess of acetate of soda as hydrated sesquioxide; this was re-dissolved and precipitated as ammonio-phosphate, and weighed as pyro-phosphate.* The magnesia was separated from the filtrate from the oxide of manganese (after it was first ascertained that this solution was entirely free from manganese) as ammonio-phosphate, and estimated as pyro-phosphate. The water was determined by igniting the powdered mineral in a glass tube closed at one end, about 10 inches in length, with a calibre of $\frac{1}{4}$ of an inch. The length of the tube effected a complete condensation of the water, which was deposited on the interior 5 or 6 inches from the open end, and the tube and contents, on being weighed, proved to have suffered a loss of less than 1 milligramme by the ignition. The water was then dried out at the ordinary temperature in vacuo over chloride of calcium. To make entirely sure that no boric acid went off with the water, I ignited a portion of the mineral which had previously been thoroughly mixed with about five times its weight of calcined magnesia, and then covered with a layer of pure magnesia. The results of this experiment confirmed the water determination made by the above method. The boric acid was determined by Stroemer's method as borofluoride of potassium. The results of the analysis are:—

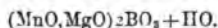
	1.	2.	3.	4.	5.	6.	Mean.	Oxy- gen.
Boric acid.....	—	—	—	—	—	31'89	31'89	22'82
Manganese oxide.....	40'08	40'20	40'01	—	—	—	40'10	9'04
Magnesia.....	17'12	16'76	17'21	—	—	—	17'03	6'81
Water.....	—	—	—	9'64	9'53	—	9'59	8'53
							98'61	

* For details of this admirable method for the estimation of manganese see T. S. Henry, *Philosophical Magazine*, IV., xvi. 197; and W. Gibbs, *American Journal of Science*, II., xlv. 216.

The analysis shows a loss of 1.39 per cent, doubtless due chiefly to the imperfections of the method employed for determining the boric acid. Calculating the loss as boric acid, the total amount of the acid is 33.28 per cent, and the oxygen ratio for BO_3 , RO , and H_2O is 22.82 : 15.85 : 8.53 or 3 : 2.08 : 1.12. The ratio 3 : 2 : 1, although not according precisely with the analyses, is nevertheless probably the true ratio. It requires a change of but a few tenths of a per cent of water to make this ratio. In fact, in what appeared to be a fresher and less altered specimen than that above analysed, I obtained but 8.93 per cent of water, which would change the amount of boric acid calculated as loss to 33.94 per cent. Correcting the oxygen to correspond to these, we have for BO_3 , RO , H_2O , 23.27 : 15.85 : 7.94, or almost exactly 3 : 2 : 1, or, considering the water basic, a ratio of 1 : 1, thus brings out a most interesting relation between this species and native boric acid, which has the formula $3\text{H}_2\text{O} \cdot \text{BO}_3$. Sussexite may be regarded an analogous compound, in which two-thirds of the water is replaced by manganese and magnesia, and we may write for its formula—



or, if the water be not considered basic, it may be represented by—



The former I believe to be the correct view of the composition of the mineral.

In some of its physical and chemical characters, sussexite resembles the mineral Szaibelyite, from southern Hungary. This mineral is found imbedded in limestone in needle-like crystals, has a hardness of over 3, a density of 3, and is a hydrous borate of magnesia. One variety analysed by Stromeyer gave the oxygen ratio of BO_3 , MgO , H_2O , 17 : 14.1 : 4, or of acid to bases including water of 17 : 18.1, or nearly 1 : 1, requiring but a slight change in the determination of water to make this also a mineral analogous in composition to boric acid, with which indeed it is already classified by Professor Dana in the recent edition of his Mineralogy.* Another member of the group is hydroboracite, a hydrous borate of magnesia and lime with the oxygen ratio of BO_3 , RO , H_2O , 4 : 3 : 1, or $(\frac{1}{2}(\text{CaO}, \text{MgO}) \times \frac{1}{2}(\text{HO})_2)\text{BO}_3$. Sussexite is at present a rare mineral, but as it occurs in a vein which is extensively mined, there is every reason to hope that it may become more abundant. Its pyrognostic properties are so very characteristic that it may readily be distinguished from any other mineral which it resembles in physical characters. In addition to fibrous willemite, I have also found chrysotile in fine fibres imbedded in the calcite of Mine Hill; it, however, requires but little familiarity with sussexite to distinguish it at a glance from these species.—*American Journal of Science and Arts*, Sept., 1863.

ON THE MANUFACTURE OF SULPHUR FROM ALKALI WASTE IN GREAT BRITAIN.†

BY LUDWIG MOND.

I wish to call your attention to a new industry—the recovery of sulphur from alkali waste—which has made very rapid progress during the last few years, and particularly to the manner in which this manufacture is now extensively carried on in Great Britain.

The importance of this subject has been so ably

pointed out to you, in 1861, by Mr. Wm. Gossage, that I may, perhaps, be allowed to repeat his remarks in full. In his very interesting paper on a history of the manufacture, after giving in detail the cost of the present raw materials used for the production of a ton of soda-ash, Mr. Gossage went on to say:—

“It will be seen from this table, that 2s. 5d. of the total cost for raw material is incurred for pyrites from which to procure a supply of sulphur; and it is a well known fact that more than nine-tenths of this sulphur is retained in the material called alkali waste, which is thrown away by the manufacturer. Thus is presented a problem, which, if it can be solved, would effect a large reduction in the cost of soda.”

“Many chemists, both scientific and practical, have given a great amount of attention to this subject. I have been so unfortunate as to be among the number, as I have devoted a great portion of my time during a quarter of a century, and a large amount of both money and labour, to this hitherto elusive subject.”

Having heard so recently this statement from a man of the eminence of Mr. Gossage, who is so well known for the indefatigable energy and perseverance which he has devoted to the many valuable inventions given by him to the world, you will have hardly expected that this problem, in which he and many able men besides him had failed, in spite of all their efforts, was very near a satisfactory solution. But only a few years afterwards we find three different processes for the recovery of sulphur from alkali waste applied in different countries in a very considerable number of works. One of these processes, which is practised at Dieuze, in France, was described to you last year by Mr. Lothian Bell, and I now beg to solicit your attention to a process which is extensively used in this country, and which is connected with my name, because I have been so fortunate in the course of my continued investigation of this subject, which has now lasted for fully eight years, as to hit upon several important improvements on former proposals, which enabled me to turn what had been impracticable schemes into an exceedingly simple and extraordinarily remunerative manufacturing process. I took out a patent for this process in 1863, and I am very glad to be able to state that its merits have been so fully recognised in this country, that it is here used exclusively, and has already been adopted by four of the largest firms, amongst whom are numbered both the founders of the British alkali and the British bleaching-powder trade, while the two other processes mentioned, which have been patented respectively two and three years later than my process, have so far only been used on the Continent, where they enjoy the advantage of cheap labour. Only one of them, called Schaffner's process, has been tried on some scale in an English works. It has, however, been quickly abandoned, and my process has been adopted instead.

All the three processes named are based on the following reactions:—

1st. The conversion of the insoluble compounds of calcium and sulphur in the waste into soluble compounds by the action of the oxygen of the atmospheric air.

2d. The removal of these soluble compounds from the rest of the waste by lixiviation with water.

3d. The separation of sulphur from the liquors so obtained by muriatic acid, which is employed either as a weak watery solution, or mixed with a solution of chlorides of iron and manganese, as it is obtained as a by-product of the manufacture of bleaching powder.

* Dana's Mineralogy, 5th edition, p. 593.

† British Association, Norwich Meeting, Section B.

A proposal to use the same reactions for the recovery of sulphur from waste has already been made by Mr. W. H. Leighton, in a patent dated October, 1836, and after a long lapse of time, during which they were apparently wholly lost sight of, similar processes have been patented by Messrs. Townsend and Walker, J. L. Jullion, and A. Noble, on the 11th of December, 1860, the 9th of February, 1861, and the 6th of July, 1861, respectively.

All these processes would certainly have separated sulphur from the waste, as had been done before by many others, but none of them would have at all met the real difficulty of the problem, which consisted in recovering a sufficiently large amount of sulphur from the waste, and at a reasonable price, so as to make this manufacture a remunerative concern.

In both these respects all these processes, if they ever had been put into practice, would have as sadly failed as have all other proposals in different directions.

In December, 1861, I patented a process in France, which, though still very imperfect, was certainly a considerable improvement in one respect, as it was the first which produced a reasonably large amount of the sulphur from the waste. All the former patents proposed to oxidise the waste only once, by allowing it to stand in heaps or tanks for a considerable time, and having been subsequently lixiviated, the waste was to be thrown away. I pointed out, for the first time, that the soluble compounds of calcium and sulphur produced by the oxidation of the waste increase only up to a certain maximum, and then begin to decrease again if the exposure to air is continued, but that after the removal of these soluble compounds by lixiviation, the lixiviated waste will, on renewed exposure to air, yield a second very considerable quantity of soluble sulphur compounds, and that even a third repetition of this treatment is required in order to exhaust the waste.

It was thus possible to obtain nearly three times as much sulphur from the waste as might have been done by any of the previous methods. Having had unfortunately to deal up to this time only with waste, which by some peculiarity of its manufacture was extraordinarily dense, I failed in all my efforts to oxidise it in heaps of any size, or by forcing air through any depth of it, both of which I tried repeatedly before I took out a patent. I was thus compelled to oxidise in shallow layers on large hurdles, which might have answered in small works such as I had then been connected with, where the wages of skilled workmen were about a shilling a day, and where sulphur at that time had a value of £12 per ton; but the utter impracticability of this mode of oxidation was apparent to me at once as soon as I tried to apply it in this country, where I found the extent of the works, as well as the rate of wages, so very much out of proportion to what I had known before. And very soon I was also perfectly convinced that the waste which is here obtained, being so very much more porous than all I had until then operated upon, would certainly allow of a much simpler treatment, and would in all probability enable me to realise my old favourite idea—namely, to oxidise the waste by forcing air through it, to lixiviate it in the same vessel, and to repeat this treatment until the waste is exhausted without removing it.

These views were soon found to be correct; and as I succeeded in oxidising the waste by these means in as many hours as it had previously taken days, I was even enabled to carry out the repeated oxidation and lixiviation of the waste in the same vessels in which this

waste had been originally obtained, without increasing the number of those vessels to an excessive extent. Thus manual labour was completely avoided in this part of the process, and the greatest difficulty of the problem happily overcome. The wet alkali waste, as it is obtained in the works, contains not more than 12 per cent of sulphur, only one-half of which I have so far been able to recover, while the two other processes are said to recover only 40 to 45 per cent of it. We have thus in the best case to operate three times on nearly 17 tons of waste, in order to produce 1 ton of sulphur. From this you will readily see that any process involving manual treatment of these enormous quantities of waste, and requiring their prolonged stay in the works, would be very expensive and almost impracticable in this country, and that the avoiding of this inconvenience and expense really was the vital point of the question. By my present process, all operations are effected within sixty to seventy-two hours, by means of a fan, which forces the air through the waste, and a pump to lift the liquors obtained, both of which require only an insignificant amount of steam power.

The process is carried out in the following way:—The first product of Leblanc's famous process for the manufacture of soda, called rough soda or black ash, is now almost universally lixiviated with water in an apparatus which was first used for this purpose in Great Britain, and is composed of a number of square iron tanks, connected in a very simple and ingenious way by pipes and taps, to allow the water to enter a tank filled with black ash already nearly spent, and thence to flow through others filled with black ash richer and richer in alkali, until it meets fresh black ash in the last tank, thus becoming an almost concentrated solution of alkali before leaving the apparatus. The alkali waste, or insoluble residue of the black ash, remains thus in these tanks deprived of all alkali, and as it has been immersed in the liquor throughout the whole time of lixiviation, it is consequently obtained in a very porous condition.

These tanks are always provided with a perforated false bottom, and for the purpose of applying my method the space between the two bottoms of each tank is connected with a fan by a pipe with a damper, to allow of the regulation of the quantity of air entering the tank. The pressure of air required never exceeds 6 inches of water, but usually as little as half an inch of water is sufficient, and can thus easily be produced by a common smithy fan.

As soon as the last weak alkali liquor is drained off the waste, the damper in the air-pipe is drawn, and air forced through the waste. The waste soon begins to heat, rising up to 200° F.; it gives off quantities of steam, and becomes gradually covered by spots of a bright yellow colour, which, together with the temperature of the waste and the quantities of steam passing off, enables the workman to judge very well when the proper state of oxidation has been reached. Usually this is arrived at after twelve to sixteen hours' blowing. The oxidised waste is then covered and completely lixiviated with water. As soon as the resulting liquor is drawn off air is again forced through the waste in exactly the same way as before, the waste is again lixiviated, and subsequently this treatment is repeated a third time. The weaker liquors so obtained are passed through one or more tanks filled with oxidised waste, so as to concentrate them, and this can be easily accomplished by a second system of pipes and taps connect-

ing all the tanks in a set, much in the same way as for the lixiviation of black ash, or still more simply by lifting the liquor by a pump and conducting it by a shoot to the other tanks. The whole process of oxidation and lixiviation of the waste, though it is repeated three times, is finished in from sixty to seventy-two hours, and does not require more than one and a half times the number of tanks which are generally used for the simple process of the lixiviation of the black ash. In most works sets of four tanks are employed for this latter purpose, and these have thus to be converted into sets of ten, all of which are to be connected in the usual way by pipes and taps, and are also to be connected to a fan. Four of these ten tanks are always filled with black ash in the course of lixiviation, and the remaining six with waste undergoing the treatment by my process. As soon as this treatment is finished the waste is thrown out of the tanks, and these are filled again with black ash to be lixiviated in the usual way, so that both the process of the lixiviation of the black ash and the extraction of sulphur from the waste are carried on continuously and without interruption. When the waste leaves the tanks, all the recoverable sulphur has been taken out of it; it contains only small quantities of sulphides, which are so enveloped by other compounds that they are no longer acted upon by the oxygen of the air, and can thus no more give rise to the dreadful exhalations of sulphuretted hydrogen, or to the formation of those well-known yellow drainage liquors which have hitherto caused the waste to be so great a nuisance, the one poisoning the air and the other the water, in the neighbourhood of the vast heaps of waste surrounding many works. Almost all the sulphur left in the waste exists in the form of sulphite and sulphate of calcium, which are both quite innocuous, and together with the carbonate and hydrated oxide of calcium, as well as with a little soda. Alumina and soluble silica, which are all to be found in the waste, make this waste a valuable manure for many soils and crops.

The liquor thus obtained, which is usually called sulphur liquor, is of a deep yellow colour, and contains from 4 to 7 per cent of sulphur in solution. This sulphur is present principally in the forms of hyposulphite, polysulphide, and sulphhydrate of calcium. Usually the oxidation of the waste is so regulated as to obtain liquors containing as nearly as possible so much oxygen in the form of hyposulphurous acid as is necessary to oxidise both the calcium and the hydrogen existing as polysulphide and sulphhydrate. These liquors are run into wooden vessels together with an equivalent quantity of muriatic acid, and steam is at the same time introduced, so as to keep the temperature of the mixing liquids between 140° and 150° F.

The proportions of liquor and acid can be easily and very correctly regulated by the workman according to the colour of the mixing liquids in different parts of the vessel. Black where the liquor comes in, it changes to gray and white, turning into a bright yellow where the acid meets the liquid.

At the temperature mentioned, neither sulphuretted hydrogen nor sulphurous acid are given off in appreciable quantities, but nearly all the sulphur contained in the liquor is precipitated in a very pure state. When the vessel is full of liquid, it is allowed to stand a few hours; the sulphur settles very rapidly to the bottom, and the clear supernatant liquor, which now contains principally chloride of calcium, and generally not more than one-thousandth part of either free acid or hyposulphite of calcium, is then run off.

The vessel is now filled a second and usually a third time with liquor and acid, and the sulphur which has then accumulated in it is drawn out by a door at the lower end of the vessel into a wooden box with a perforated false bottom. Here it is well washed with water, and after having been drained is melted down in an iron pot or pan. It is thus obtained very pure, containing less than 1 per cent of impurity, and surpassing in this respect all brimstone which is imported into this country.

The principal constituents of the liquor are determined in the following way:—

The hyposulphite is tested as usual by a solution of iodine and starch, after addition of acetate of zinc. Another portion of the liquor is tested directly by iodine and starch; the blue colour is then taken away by a drop of hyposulphite of sodium, and litmus and a caustic soda solution is added until all free acid is neutralised.

This free acid is equivalent to the sulphuretted hydrogen in the liquor, and the three tests lead by a very simple calculation to the calcium present as polysulphide. This polysulphide containing usually only little more than two equivalents of sulphur to one of calcium, the test gives also approximately the amount of sulphur in these liquors.

If the proportion of hyposulphite to sulphide has been quite correct, the iodine used for the first test will be one-fifth of the iodine used for the second test. In practice the liquors will of course deviate a little from these proportions; they are, however, kept within so narrow limits, that none of the firms who have so far adopted the process have considered it worth their while to avail themselves of the very simple means which I have proposed for remedying any irregularity, such as keeping a small stock of liquor rich in either hyposulphite or sulphides which the workmen might add in case of any gas being evolved during the precipitation of the sulphur.

The vessels in which this latter process is conducted are, however, always loosely covered in and connected with a chimney, so that any gases which might be evolved by accident are carried off; or they are still better connected with the fan forcing the air through the waste, so that these gases may be absorbed in passing through the waste, and thus the sulphur which they contain may also be saved.

In places where muriatic acid has a comparatively high value, and where bleaching powder is manufactured at the same time, the acid contained in the liquors which are obtained as a by-product in the last-named manufacture may be made available for the separation of sulphur from sulphur liquor, as has already been proposed by Messrs. Townsend and Walker, in 1860, and is now done on an extensive scale at Dieuze, in France.

These liquors containing also chloride of manganese, perchloride of iron, and a little free chlorine, the sulphur liquor ought in this case to contain more sulphides than where muriatic acid is used alone, so that the two last-named constituents may also be reduced by these sulphides. In all other respects I carry on the operation in exactly the same way as described before. The sulphur obtained is of a dark colour, and contains up to 5 per cent of impurities. By these means a second waste and offensive product may be turned to advantage and made comparatively harmless.

The latter object can then still more efficiently be obtained by recovering the manganese also from these liquors. A process used since several months, at Dieuze,

effects this only to the small extent of about one-twelfth of the manganese contained in the liquors.

The most satisfactory and complete results in this respect have, however, been obtained long ago by the well-known process of Mr. Dunlop, which has been very largely worked for a considerable number of years at Messrs. Charles Tennant and Co.'s immense chemical works at Glasgow.

I have still to refer to another method of separating sulphur from sulphur liquor, which I have used before adopting the one already described, and which is still used by many German works. In this method the sulphur liquor is first treated by sulphurous acid, until all the sulphides are converted into hyposulphites. It is then heated by steam to 212° F., and muriatic acid is added by degrees until all the hyposulphite is decomposed. Steam is then continued to be introduced until all the sulphurous acid is driven off, and this is conducted into a second vessel filled with the original liquor, in order to effect there the above-mentioned conversion of the sulphides into hyposulphites. I found, however, that this could only be arrived at with liquors originally very rich in hyposulphite, as, in contradistinction to general notions, only very small quantities of sulphurous acid could be obtained by the second part of this method, while large quantities of sulphate were formed instead. The hyposulphite of calcium and muriatic acid form, in the first place, sulphur and trithionate, and the latter is then decomposed into sulphur, sulphate, and sulphurous acid.

Though a considerable saving of muriatic acid could thus be effected, it was by no means an equivalent for the sulphur lost in form of sulphate; and, especially in this country, a saving of muriatic acid would be rather undesirable. The greater its use the smaller will be the enormous quantity still run into the rivers, which, according to the latest official statements, is more than one half of the acid produced, and amounted, in 1866, to above 120,000 tons of anhydrous hydrochloric acid, equal to 360,000 tons of commercial acid of 32° Twaddle.

I am sorry not to be able to give you a more detailed account of the reactions involved in this process. Though the final results are simple, the details of the different changes taking place are very complicated. It is very probable that all the numerous compounds of hydrogen, sulphur, and oxygen are formed at one time or another, as I have been able distinctly to recognise all those which our present knowledge allows us to detect in presence of the others, including persulphide of hydrogen, trithionic, and pentathionic acid. Unhappily, our knowledge of these compounds is very imperfect, but I hope that the prominent part which they now play in an important manufacture may stimulate some of our eminent scientific men to investigate this long-neglected class of bodies. I have no doubt that they would thus confer a great boon upon a new and rapidly-growing industry, and would at the same time obtain results of considerable interest for theoretical chemistry, as these compounds apparently conform but little to modern chemical views.

By the process which I have endeavoured to sketch out to you, fully one-half of the sulphur contained in the waste is recovered, and I have no doubt that this quantity will yet be considerably increased by some further experience, as I have already been able to obtain much more during several consecutive weeks. As you can easily judge yourselves, the cost of plant and the working expenses are very small. A plant for the

recovery of 10 tons of sulphur per week can be put up for about £800, and the sulphur can be made at £1 per ton. The recovered sulphur being very pure, it is not used to replace pyrites in the manufacture of soda, but for purposes where Sicilian sulphur or brimstone has hitherto been employed, this Sicilian sulphur having a much higher value than the sulphur in pyrites, and averaging upwards of £6 per ton. And so large are the quantities of brimstone used, that the British alkali trade, in spite of its enormous extent, could only produce a small portion of the sulphur yearly exported from Sicily, which country has hitherto had the monopoly of the supply of this article. According to a trustworthy statement, the total yearly export of sulphur from Sicily has risen to above 200,000 tons—according to another authority, even to 300,000 tons—of which about 50,000 tons are brought to Great Britain. The alkali waste produced from about 400,000 tons of common salt, which are now annually used by the British alkali trade, would yield 40,000 tons of sulphur. The trade is thus in a position by applying this process to the waste yearly obtained, and to only a small quantity of the waste which has accumulated in the neighbourhood of the works to such an alarming extent, to supply this country with all the sulphur which it consumes, and for which it now pays to Italy above £300,000 a year. Considering the great importance of this raw material for many important branches of industry, I will only mention the bleaching of woollen and silk fabrics, and the employment of sulphur for the suppression of the much dreaded disease of the hop-plants, but particularly its indispensability in the manufacture of gunpowder, upon the effects of which the fate, and the independence, and the liberty of nations, to so great and regrettable an extent, still depend. I believe it to be a matter of congratulation to your country that it should possess the means of furnishing its own supply of this valuable substance, and of producing it also at a much cheaper rate than it can be obtained at the best situated mines in Sicily.

The President, Professor FRANKLAND, in expressing the thanks of the Section to Mr. Mond, remarked that his communication was one of great importance. In his (Dr. Frankland's) capacity as River Commissioner, it had been his duty to inquire into the great nuisance at present created by alkali waste, which he had found in many cases to be intolerable. He had lately seen a river, called Sankey Brook, which, in consequence of the drainage liquor from the surrounding waste heaps meeting there with hydrochloric acid, which also ran from the alkali works into this river, was almost saturated with sulphuretted hydrogen, and gave off the dreadful smell of this noxious gas for miles.

He had had an opportunity of seeing Mr. Mond's process at work on a very large scale, and to witness its great simplicity and effectiveness, and though he was not competent to judge of the mercantile profit of the process, it was his opinion that the manufacturers were morally bound to adopt it even if it could only cover its cost.

Mr. A. E. FLETCHER, Inspector of Alkali Works under the Alkali Act, said he very often had reason to complain of the great nuisance caused by the waste, which he believed had increased lately. He had known Mr. Mond's process to work satisfactorily for several years, and the best proof of the practicability of the process he considered to be that several of the largest firms had taken it up successfully.

Mr. E. C. STANFORD stated, that, as an inhabitant of

Considering the importance of pepsin as a digestive agent, the preparation of it has become a common affair of trade. In France it is obtained from the stomach of the pig by carefully washing it, then scraping off the soft mucous membrane, rubbing it down with a little water, filtering, precipitating the foreign matters with acetate of lead, again filtering, and then precipitating the excess of lead with sulphuretted hydrogen, after which it is allowed to stand, or it is warmed, to get rid of excess of sulphuretted hydrogen; it is then filtered once more, and after carefully evaporating to the consistence of syrup it is consolidated with dry starch. In this country it is prepared

from the stomach of the sheep as well as of the pig, and we have our *pepsina ovis* and *pepsina porci*; besides which, the use of lead and sulphuretted hydrogen are avoided by precipitating the foreign matter with alcohol, pepsin being soluble in weak spirit. On the lecture table are specimens of Boudault's pep-in, as well as those of Mr. Morson, of London, Messrs. Turner and Co., and Mr. Claridge, of Warwick, all of which are also in operation, showing their relative digestive powers on animal fibrin.

The pepsin preparations on the table contain varying proportions of starch, as from 29 to 50 per cent; but the digestive power of any specimen may be easily tested by putting a dose of the preparation into a small bottle with half an ounce of water, acidulating with twenty drops of hydrochloric acid, and then adding half a drachm of hard boiled egg chopped small, or the same weight of lean meat, or 120 grains of the fibrin of blood. On standing in a warm place at a temperature of 100 to 110, the digestion should be complete in two hours. Tried in this manner, Dr. Pavy found, some time ago, that nearly all the preparations in common use were inert; not so, however, at the present time, for, as you will notice, digestion is proceeding rapidly.

I am told that the strongest pep-in is obtained from young healthy pigs which are kept hungry, and are then excited by savoury food which they are not all wed to eat; while the influence of it is strong upon them, and the secretions are pouring out in expectation of the meal, the animals are pithed.

Pepsin, like diastase, is rendered inert by a temperature of from 120° to 130° F.; and, therefore, very hot drinks are hurtful.

Pancreatic fluid is a secretion from the pancreas or sweet-bread. Until recently its true digestive functions were not well determined. It is a colourless fluid of a gravity of 1.008 or 1.009. Like the saliva, it is generally a little alkaline, and it contains about 1.3 per cent of solid matter, one-eighth of which is a nitrogenous organic substance of the nature of ptyalin or diastase, and is called pancreatin.

More than twenty years ago, Bernard proved, what Valentin had long before suspected, that the pancreatic fluid was concerned in the digestion of fatty matters; but he fell into error in supposing that its action was to saponify the fat, and to set glycerin free. Here is a specimen of glycerin and of lead-soap obtained from fat upon which the pancreatic fluid had previously acted, showing that saponification had not been effected. The true action of the pancreatic secretion is evidently to break up the large granules and crystals and globules of oil and fat, into myriads of minute particles of from 1-3,000th to 1-15,000th of an inch in diameter. In this way the fat is emulsified and converted into a milky liquid, which mixes freely with water, and passes through the tissues of the intestines into the lacteals. We are indebted for this knowledge to Dr. Dobell, who had long been of opinion that the functions of the pancreas were important in certain diseases, and required elucidation. With the assistance of Mr. Julius Schweitzer, of Brighton, the then manager of the laboratory of Messrs. Savory and Moore, he made a large series of investigations into the properties of the pancreatic secretion, and he found that when the fresh pancreas (and best of the pig) is rubbed down in a mortar with twice its weight of hog's lard, it rapidly emulsifies it; and on adding about four or five times the bulk of water, and straining through muslin, there

is obtained a thick milky liquid of the consistence of cream, which gradually consolidates. If this be treated with ether, the pancreatised fat dissolves; and when the ether is separated by distillation, there remains the purified pancreatised fat, which is still miscible with water; in fact, when mixed with four or five parts of water it forms the creamy emulsion which is used dietically and medicinally in doses of a teaspoonful at a time.

The properties of the pancreatic fluid have been well described by Dr. Dobell, in a paper recently read before the Royal Society of London; and it would seem that the fluid has not only the remarkable property of emulsifying oil and fat, and so rendering them capable of absorption, but it has also the power of dissolving starch by converting it into glucose. In this respect its action is like that of saliva, but it is much more energetic; for in its fresh state one part of the pancreas will dissolve eight parts of starch, and even after it has emulsified fat it will dissolve two parts of starch. It is, therefore, a powerful agent of digestion, in so far as fat, and starch, and young cellulose are concerned, but it has little or no action on albuminous substances.

I am indebted to Dr. Dobell and to Mr. Morson for the specimens of pancreatin and pancreatised fat upon the table. The first of these preparations is obtained by treating the fresh pancreas with water, and carefully evaporating the solution to the consistence of syrup, and then consolidating it with the flour of malt. Perhaps the pancreas, powdered and mixed with malt, would be a stronger preparation.

The bile is a complex liquid, consisting of biliary acid (taurocholic, glycocholic, &c.) in combination with soda. Its reaction is slightly alkaline, and it contains about 14 per cent of solid matter, not less than 12 of which are organic.

The true function of the bile is unknown; perhaps it aids in neutralising the acid peptones from the stomach; perhaps, also, in emulsifying fat; and it may be that it helps the digestion of starchy foods. Lehmann thinks it is a rich residuum from the manufacture of blood globules in the liver, and that it is secreted into the alimentary canal, only to be reabsorbed into the blood. Mr. Lee, also, is of opinion, from his examination of the foetal liver, that it separates a highly nutritious substance from the portal blood, which is elaborated in the intestines. Its functions, however, are manifestly obscure.

Lastly, the intestinal secretion which is thrown out along the whole course of the small intestines, is, according to the researches of Bidder and Schmidt, a powerful agent of digestion; for it combines the activity and digestive power of all the other secretions—starch, fat, and albuminous substances being all equally well digested by it.

The food, therefore, coming into contact with these special solvents, and being copiously drenched with fluid, gives up its nutritive constituents. Admirable, however, as this provision is for the digestion of food, a considerable portion of useful matter passes through the bowel unchanged; for cellulose, starch globules, and muscular fibre are common constituents of sewage. Dr. Lyon Playfair says that in the case of an adult man, with good digestion, one-twelfth of the nitrogen of the food passes away with the excreta, and others have computed it at an eighth. In a dry state the faeces of man contain about 6.5 per cent of nitrogen, and in the fresh state, 1.7. In Ranke's experiments, it was ascertained that the nitrogen in the faeces was to that in the

urine as 1 to 12 5. Much of this is, doubtless, derived from the secretions which have done the work of digestion, and have thus become effete; indeed, Dr. Marcet is of opinion that the alvine discharges are chiefly composed of the residuum of albuminous substances which have been secreted into the bowel for the purposes of digestion. In ordinary individuals they amount to from 4 ozs. to 5½ ozs. a day—(Wehsurg says 4½ ozs.; Liebig, 5½ ozs.; Lawes, 4½ for a middle-aged adult, and 6½ for a person over fifty—the mean amount for adult males being 4½ ozs., and for adult females 1½ ozs.); and when calculated in a dry state they amount to about 1½ oz. daily. It would seem, however, that when indigestible and irritating food is used, the quantity of fecal matter is increased, as if the food was hurried through the intestines without undergoing digestion. At the Wakefield Prison, for example, it was found that when brown bread, containing bran, was given to the prisoners, the weight of the feces was 7 ozs. per head daily; and the same fact has been observed at the Coldbath-fields Prison.

With this general account of the digestive function of the different secretions discharged into the alimentary canal, we are prepared to inquire into the digestibility of different alimentary substances.

Nitrogenous or proteinaceous, or albuminous substances, which constitute the leading articles of diet, are evidently digested by the gastric juice and the intestinal mucus. In the former case they are converted into acid peptones, of which, according to Lehmann, there are several varieties, as albumino-peptones, fibrino-peptones, caseino-peptones, gelatino-peptones, &c., according as they are derived from albumen, fibrin, casein, gelatin, &c., and of these substances the fluid form of albumen is most easily converted; then coagulated albumen, then fibrin, then casein, and lastly, the derivatives of albumen, gelatin, chondrin, and cartilage; the tegumentary forms of albumen, as hair, wool, feathers, &c., being entirely indigestible. Here is an example of the indigestibility of hair—it is a ball of it, obtained from the alimentary canal of a cow, and has come from the calf which the cow has a habit of licking. Serpents and other animals that swallow their prey entire, digest the soft tissues and bones, but they disgorge the hair and feathers untouched.

It is difficult to speak of the comparative digestibility of different nitrogenous foods; for the well-known experiments of Dr. Beaumont on the Canadian with a fistulous opening in the stomach, and even experiments made in bottles with pepsin, do not represent the full and natural conditions of the process: at the present time there are, no doubt, great differences in the digestibility of different animal substances. Dr. Beaumont found, in his inquiries, that soured pigs' feet and soured tripe were the most digestible of all foods, and that boiled tendon of meat was the least digestible. The following, in fact, are the times given by him for the chymification of different animal foods:—

Articles of diet.	How cooked.	Time of chymification.
		<i>h. m.</i>
Pigs' feet (soured).....	Boiled	1 0
Tripe (soured).....	Do.	1 0
Eggs (whipped).....	Raw	1 30
Salmon trout.....	Boiled	1 30
Venison steak.....	Broiled	1 30
Brains.....	Boiled	1 45
Ox liver.....	Boiled	2 0
Codfish (cured dry).....	Boiled	2 0

Articles of diet.	How cooked.	Time of chymification.
		<i>h. m.</i>
Eggs.....	Roasted	2 15
Turkey.....	Boiled	2 25
Gelatine.....	Do.	2 30
Goose.....	Roasted	2 30
Pig (sucking).....	Do.	2 30
Lamb.....	Broiled	2 30
Chicken.....	Fricassee	2 45
Beef.....	Boiled	2 45
Do.....	Roasted	3 0
Mutton.....	Boiled	3 0
Do.....	Roasted	3 15
Oysters.....	Stewed	3 30
Cheese.....	Raw	3 30
Eggs.....	Hard boiled	3 30
Do.....	Fried	3 30
Beef.....	Do.	4 0
Fowls.....	Boiled	4 0
Do.....	Roasted	4 0
Ducks.....	Do.	4 0
Cartilage.....	Boiled	4 15
Pork.....	Roasted	5 15
Tendon.....	Boiled	5 30

It is doubtful, indeed, if cheese or tendons are ever digested except in small quantity; and it is evident, from these experiments, as I shall hereafter explain, that cooking has considerable influence on the digestibility of food.

It is a curious problem why the stomach does not digest itself, seeing that it belongs to the class of most easily digestible substances, as tripe. Hunter explained it by referring the protective power to the vital force, for when dead the stomach digests itself in common with the food contained in it; but Bernard's and Pavy's experiments have proved that this is not the right explanation, for if the legs of living frogs, or the ears of living rabbits, are introduced into the stomach of a dog through a fistulous opening in the side, they digest like other proteinaceous substances. Liebig supposed that the protective power was in the thick mucus which lined the stomach, but Pavy denuded a part of the inner walls of a dog's stomach, and found that the tissue did not digest, but, on the contrary, quickly healed, and he is of opinion that the protective power is in the alkaline condition of the blood, which circulates so freely through the capillary vessels of the stomach during digestion.

Starchy substances and cellulose are digested by the ptyalin of the saliva, and the pancreatin of the pancreatic fluid, as also by the animal diastase of intestinal mucus. The solution is effected by the conversion of the starch and cellulose into a low form of sugar, called glucose, which is freely absorbed into the circulation, or becomes changed into lactic acid, that serves so important a function in the digestion of nitrogenous matter. The time necessary for the digestion of different vegetable substances, as determined by Dr. Beaumont, is as follows:—

Articles of diet.	How prepared.	Time of chymification.
		<i>h. m.</i>
Rice.....	Boiled	1 0
Apples (sweet and mellow).....	Raw	1 30
Sago.....	Boiled	1 45
Tapioca.....	Do.	2 0
Barley.....	Do.	2 0
Apples (sour and mellow).....	Raw	2 0
Cabbage with vinegar.....	Do.	2 0

Articles of diet.	How prepared.	Time of chymification.	
		h.	m.
Beans	Boiled	2	30
Sponge cake	Baked	2	30
Parsnips	Boiled	2	30
Potatoes	Roasted	2	30
Do.	Baked	2	33
Apple dumpling	Boiled	3	0
Indian corn cake	Baked	3	0
Do. do. bread	Do.	3	15
Carrot	Boiled	3	15
Wheaten bread	Baked	3	30
Potatoes	Boiled	3	30
Turnips	Do.	3	30
Beets	Do.	3	45
Cabbage	Do.	4	0

It would be seen from this that the time of digestion is in proportion to the amount of cellulose or woody tissue in the food. No doubt there is a more complete solution of these matters in the small intestines, where the pancreatic fluid and intestinal mucus, aided by the alkaline condition of the fluids, exert the greatest actions on them, but it is very doubtful whether hard cellulose and woody matter are at all digested by man. Even in the case of the pig, whose digestive powers are singularly active, it is thought by Messrs. Lawes and Gilbert, from their experiments on the fattening of animals, that there is little or no digestion of these substances; and under any circumstances, a very prolonged contact with the secretions is necessary for their digestion. Raw starch will pass a considerable distance along the alimentary canal of man without much change, and it is only towards the end of the small intestines that the starch granules undergo marked disintegration. Those animals which feed entirely on vegetables have always a contrivance for keeping the food for a long time in contact with the secretions. It occurs as the paunch in ruminants, the crop in birds, the large cæcum in rabbits and other rodentia, and as the long alimentary canal of all of them; but even then a large portion of the vegetable tissue passes through the bowels unchanged. Cooking, grinding, and otherwise disintegrating the tissue helps considerably in the digestion of it.

Gum and pectin are probably not digested at all, for as they are unchanged by contact with the secretions, and are incapable of dialysis or absorption, they must pass through the alimentary canal without serving any purpose in nutrition.

Fatty matters are digested by the emulsifying action of the pancreatic fluid; and by being thus broken up into extremely minute globules they are freely admitted into the lacteal vessels; in fact, the emulsified globules of fat are seen covering the villi of the intestines, penetrating their tissues, pervading the subjacent cellular bodies, and thus entering the lacteals; and no doubt the peristaltic action of the intestines contributes largely to this emulsifying process.

Saline substances are generally soluble in water, and are therefore easily absorbed, but when this is not the case, as with the earthy phosphates, they are attacked by the acid constituents of the gastric juice.

And here I may remark that the great aids to digestion are:—

1st. Proper selection of food, according to the taste and digestive power of the individual.

2nd. Proper treatment of it as regards cooking, flavouring and serving it.

3rd. Proper variations of it, both to its nature and treatment, so that the appetite may not fail.

4th. Exercise, warmth, and a genial disposition.

Functions of Food.—Although much attention has been directed to this important subject—viz., the immediate and remote functions of food—yet it must be admitted that the difficulties of the question have not been surmounted, and that we are hardly able to particularise the phenomena which are incidental to its transformations. We can see clearly enough that its ultimate destiny is the manifestation of force—the letting loose of the cosmical agencies which were bound up in it—when, by undergoing oxidation, it returns more or less completely to its original forms—carbonic acid, water, and ammonia; but how and where these changes occur, and what are the subsidiary phenomena and concurrent functions, besides those of common motion and animal heat, are as yet almost unknown to us. Nor are we sufficiently acquainted with the special attributes of the principal constituents of food, as the albuminous, the fatty, the farinaceous, the saccharine and the saline; for although the well-known opinions of Liebig, with regard to the dynamic or force-producing functions of the nitrogenous or plastic elements of food, and of the thermotic or respiratory powers of the carbonaceous have been generally received, yet there are abundant reasons for believing that both of these classes of food may perform exactly the same functions in respect of the development of force; and, again, it is more than probable that the nitrogenous or plastic constituents of food may, like the carbonaceous, be oxidised and consumed in the living body without ever entering into the composition of tissue. In these respects, therefore, there are great points of divergence from the views of Liebig.

Looking, however, at the proximate elements of food, it may, perhaps, best serve our present purpose if we inquire generally into the several functions of water, albuminoid compounds, fatty substances, farinaceous and saccharine matters, and mineral salts.

1st. Water is unquestionably of great physiological value, for as much as 75 per cent. of the muscular tissue of the animal frame is composed of it; and of the 20 lbs. of blood which an average-sized adult contains in his body, about 15½ lbs. are water. It is computed, also, that not less than 30 lbs. of fluid ebb and flow daily from the blood and alimentary canal by secretion and absorption. Bidder, indeed, estimates that about 28.6 lbs. of chyle and lymph are carried daily by the thoracic duct alone into the circulation—a quantity of fluid that amounts to about one-fifth of the entire weight of the adult human body; and then with regard to the excretions, we find that rather more than 1 lb. of water is exhaled daily by the breath, about 1½ lbs. by the skin, and not less than 2½ lbs. by the kidneys, making altogether about 5½ lbs. per adult daily.

These results indicate the importance of water in the functions of the animal body. It serves, indeed, to dissolve the food and carry it into the circulation; to effect the distribution of it throughout the system; to dissolve effete matters, as the metamorphosed constituents of worn-out tissues, and so convey them out of the body; to establish the chemical activity which is necessary for nutrition and decay; to combine mechanically with the tissues and lubricate them, so that they may perform their functions; and, lastly, to evaporate by the air-passages and skin, and thus maintain the proper temperature of the body.

2nd. The second constituents of our food—viz., albuminous, nitrogenous, or plastic matters—were once, and until very recently, thought to have the sole func-

tion of constructing and repairing the muscular parts of the body; and having so entered into the composition of tissues, their oxidation and decay were attended with manifestations of force which were the working powers of the animal machine. "We see," says Liebig, "as an immediate effect of the manifestation of mechanical force, that a part of the muscular substance loses its vital properties—its character of life; that this portion separates from the living part, and loses its capacity for growth and its power of resistance. We find that this change of properties is accompanied by the entrance of a foreign body (oxygen) into the composition of the muscular fibre; and all experience proves that this conversion of living muscular fibre into compounds destitute of vitality is accelerated or retarded according to the amount of force employed to produce motion. Nay, it may safely be affirmed that they are mutually proportional; that a rapid transformation of muscular fibre, or, as it may be called, a rapid change of matter, determines a greater amount of mechanical force; and conversely, that a greater amount of mechanical motion (of mechanical force expended in motion), determines a more rapid change of matter." He further remarks that "the amount of azotized food necessary to restore the equilibrium between waste and supply is directly proportional to the amount of tissue metamorphosed," that "the amount of living matter, which in the body loses the condition of life, is, in equal temperatures, directly proportional to the mechanical effects produced in a given time." That "the amount of tissue metamorphosed in a given time may be measured by the quantity of nitrogen in the urine;" and "that the sum of the mechanical effects produced in two individuals in the same temperature is proportional to the amount of nitrogen in their urine; whether the mechanical force has been employed in voluntary or involuntary motions; whether it has been consumed by the limbs, or by the heart and other viscera."

These are the generalisations of Liebig, and they go to show, not only that the dynamical action of the animal body depends wholly on the transformation of muscular tissue, and may be measured by the quantity of nitrogen excreted as urea; but also that no oxidation of nitrogenous matter can take place until it has passed from the condition of food to tissue, and has thus become organised. According to this view, the mechanical force of the human machine is derived entirely from its own combustion, and not from the oxidation of matters contained in the food.

For some time past there have been suspicions that this view of the case is not correct; and the doubts of physiologists have been strengthened by the circumstance that great labour might be performed for a short period without the use of a nitrogenous diet; and that while there was always a relation between the quantity of nitrogen in the food and that excreted as urea, there was no such relation between the dynamical actions of the body and the proportions of urea. Moritz Troube, in fact, asserted in 1861, after a careful examination of the subject, that all muscular force was derived from the oxidation of fat and hydrocarbons, and none from the oxidation of tissue. Haldenham, in 1864, arrived at a similar conclusion; and Donders was likewise of opinion that tissue transformation would not account for all the force of the animal body.

The hypothesis of Liebig has been further shaken by the investigations of Dr. Edward Smith, who has shown that the proportions of nitrogen in the urine does not

increase with exercise, although the amount of carbonic acid exhaled by the lungs does. But the most convincing proof of the fallacy of the hypothesis was furnished in 1866 by the experiments of Dr. A. Fick, the Professor of Physiology at Zurich, and Dr. J. Wislicenus, the Professor of Chemistry.

On the 29th of August of that year they prepared themselves for an ascent of the Faulhorn, one of the Bernese Alps, which rises 6,417 feet above the Lake of Brienz. For seventeen hours before the journey, they took nothing in the way of solid food but cakes composed of starch, fat, and sugar; and on the following morning, at half-past five o'clock, they began the ascent, choosing the steepest of the practical paths from the little village of Iseltwald on the Lake of Brienz. At twenty minutes past one in the afternoon their journey was accomplished without fatigue, and from that hour till seven in the evening they remained at rest in the hotel at the top of the mountain. During the whole of that time (a period of thirty-one hours) they took no other food but the non-nitrogenous biscuits; but at seven o'clock they had a plentiful meal of meat, &c.

The urine was collected at three intervals, viz. :—

1st. From 6 o'clock p.m. of the 29th, to 5 a.m. of the 30th; and this they called the night urine.

2nd. From 5 a.m. of the 30th, to 1.20 p.m.; and this they called the work urine.

3rd. From 1.20 p.m. to 7 p.m.; and this they called the after-work urine.

4th. From 7 p.m. on the 30th, to the morning of the 31st; and this they called the night urine.

All these were analysed for nitrogen, and the results were as follows:—

Grains of Nitrogen Secreted by		
	Fick.	Wislicenus.
1st. Night urine.....	106.7	103.1
2nd. Work urine.....	51.1	48.3
3rd. After work urine	37.5	37.3
4th. Night urine.....	74.3	82.5
	88.6	85.6

So that not only were they able to perform the work without a nitrogenous diet, but the quantity of nitrogen excreted was less during the work than before or after. Even calculated at the hourly rate of excretion, it stands thus:—

Grains of Nitrogen Hourly Excreted.		
	Fick.	Wislicenus.
During 1st night.....	9.72	9.41
During time of work.....	6.33	6.02
During rest after work.....	6.17	6.17
During 2nd night after work....	6.94	7.87

The work which they had performed was estimated thus:—Fick weighed 145.5 lbs. avoirdupois, and Wislicenus 167.5 lbs.; and as they had ascended 6,417.5 feet, it is clear that Fick had raised 933,746 lbs. one foot high (145.5 × 6,417.5), and Wislicenus 1,074,931 lbs. (167.5 × 6,417.5); so that for an expenditure of muscular tissue, represented in the one case by 88.6 grains of nitrogen, and in the other by 85.6 grains, the foregoing amounts of work had been done. Now, as 1 of nitrogen represents 6.4 of dry muscular tissue, it is evident that Fick had consumed 567 grains of muscle, and Wislicenus 547.8 grains.

At the time of the experiment, the thermotic and mechanical powers of these proportions of flesh were not accurately known, but they have been since determined in a very careful manner by Dr. Frankland, who finds that when pure dry lean of beef, albumen, and

urea are completely oxidised in a proper apparatus, they develop the following amounts of heat and mechanical force:—

	Lbs. of water raised 1° F.	Lbs. lifted 1 ft. high.
10 grains of pure dry beef.....	13.1	10.083
" " " albumen.....	12.8	9.878
" " " urea.....	0.6	4.36

In considering the mechanical power of muscular tissue, it must be remembered that it is never completely oxidised in the animal body, but it is changed into carbonic acid, water, and about one-third of its weight of urea, so that the potential energy of muscle is not so great as in the preceding results. Calculated, indeed, according to the proportions of urea formed, the tissues of Fick and Wislicenus were capable of the following amounts of physiological energy:—

	Fick.	Wislicenus.
Quantity of muscle consumed.....	567.0 grs.	547.8 grs.
Actual energy if fully burnt.....	571,706 ft.-lbs.	552,347 ft.-lbs.
Available energy, deducting the urea..	563,466 ft.-lbs.	544,386 ft.-lbs.
Work actually done.	933,746 ft.-lbs.	1,074,931 ft.-lbs.

So that, in the case of Fick, 370,280 ft.-lbs. of work, and in the other 530,545 ft.-lbs. are unaccounted for. But this is not all, for besides the mere labour of ascending the mountain, there were the movements of respiration, and the beating of the heart, and other motor actions, to be added to the work actually done.

Now each beat of the heart is estimated as equal to a lift of 4.6 lbs. one foot high; and it is considered from Donder's well-known investigations that the work of an inspiration is nearly the same—viz., 4.54 lbs. a foot high. Fick says that during the ascent his pulse beat at the average rate of 120 a minute, and his respirations were 25. The beating of his heart, therefore, during the five and a half hours actually taken in the ascent was equal to 182,556 lbs. lifted a foot high; and the respiration to 37,455 lbs. If the internal labour, or, as it may be called, the *opus vitale* of Wislicenus was in proportion to his bodily weight, as compared with Fick's—that is as 7 to 6, then the ascertainable work done, was to the power of the muscle consumed, as follows:—

	Fick. Ft.-lbs.	Wislicenus. Ft.-lbs.
Work of ascending the mountain...	933,746	1,074,931
Work of circulation.....	182,556	212,982
Work of respiration.....	37,455	43,698
Total ascertainable work.....	1,153,757	1,331,611
Actual energy of the consumed muscle.....	563,466	544,386

Energy unaccounted for..... 590,291 787,225

From which it appears that, taking only the three factors of ascertainable work—viz., external labour, circulation, and respiration—and disregarding other unascertainable motor actions of the body, which are estimated by many as greater than all the rest, the work actually performed exceeds the energy of the oxidised muscle by more than as much again.

It may be said, and truly, that these experiments of Fick and Wislicenus were of too short a duration to afford an opportunity of ascertaining whether the oxidised muscle was not afterwards excreted; but the recent researches of Dr. Parkes on the elimination of nitrogen by two healthy men (soldiers) in the prime of

life, during a period of seventeen days, and under different conditions of diet and exercise, have shown that, although the results are not altogether accordant with those of Fick and Wislicenus, yet the conclusions are certainly borne out, that a non-nitrogenous diet will sustain the body during exercise for a short time, and that exercise produces no notable increase in the nitrogen of the urine. On the contrary, the amount of urea is actually less during work than at a period of rest; and he thinks that the muscle, instead of oxidising, and therefore losing its substance during labour, actually appropriates nitrogen and grows—its exhaustion being dependent, not so much on its decay as on the accumulation of the oxidised products of hydrocarbon, as lactic acid, &c., in its tissue, which require rest and time for their removal. That some decay of the muscle takes place there can be no doubt; for, as Dr. Parkes observes, "although it is certain that very severe exercise can be performed on non-nitrogenous diet for a short time, yet it does not follow that nitrogen is unnecessary. The largest experience shows that nitrogen must be supplied if work is to be done, but that the amount must augment with the work. For a short period the well-fed body possesses sufficient nitrogen to permit muscular exertion to go on for some time without a fresh supply; but the destruction of nitrogenous tissues in these two men is shown by the way in which, when nitrogen was again supplied, a large amount was retained in the body to compensate for previous deprivation." It would seem, too, from the great exhaustion of the men on the second day of a non-nitrogenous diet, that their muscles and nerves were becoming structurally impaired, and that if the experiments had been continued for a third day there would have been a large diminution in the amount of work. The work which they actually performed on a non-nitrogenous diet of starch and butter, in the form of biscuits and arrowroot, was walking exercise of 23.76 miles the first day, and 32.78 the second. The first day's work occupied, with intervals of rest, about ten hours and three-quarters, and it was done without fatigue; but the second day's work took twelve hours, and the last thirteen miles were accomplished with great fatigue. Calculated according to Haughton's formula (that walking upon a level surface is equal to lifting 1-20th of the weight of the body through the distance walked), the labour in the two days was, for—

	S. Weighing with clothes 162.4 lbs.	T. Weighing with clothes 124.2 lbs.
The first day.....	1,018,676 ft.-lbs.	779,062 ft.-lbs.
The second day.....	1,405,397 "	1,074,817 "
Total work.....	2,424,073 "	1,853,879 "
Total nitrogen excreted.....	529.16 grains.	492.46 grains.
Equal to muscle oxidised.....	3,386.92 "	3,151.74 "
The energy of which (minus urea) is...	3,267,361 ft.-lbs.	3,040,483 ft.-lbs.

The amount of nitrogen excreted during the time of actual exercise was only about half the above; and, calculated in this way, it would only account for about two-thirds of the labour-force. The results therefore prove that although the basis for the calculations of Fick and Wislicenus was too narrow for accurate deductions, yet the mechanical force of the oxidised muscle is not sufficient to account for external and internal work;

and the conclusion is that, in the above experiments, the motive power of the muscles was not derived from their own oxidation of non-nitrogenous matters.

The researches of Dr. Edward Smith throw additional light on the subject, for he ascertained that the amount of carbonic acid exhaled by the lungs was in proportion to the actual work performed.

During sleep it was at the rate of...	293 gra. per hour.
When lying down and approaching sleep.....	355 " "
In a sitting posture.....	491 " "
When walking two miles an hour...	1,088 " "
When walking three miles an hour..	1,552 " "
And when working at the treadmill.	2,926 " "

It is highly probable, therefore, that the largest amount of muscular force is derived from the hydrocarbons of our food; not that the nitrogenous matters of it may not also be a source of power; but there is no necessity, as Liebig supposes, for their being previously constructed into tissue. The experiments of Mr. Savory, in fact, show that rats can live and be in health for weeks on a purely nitrogenous diet, and it is nearly certain that under these circumstances the nitrogenous matters are mostly oxidised without entering into the composition of tissue. This, as I have said, is the main point of divergence from the hypothesis of Liebig; and it is further indicated by the fact that the amount of nitrogen excreted is not in proportion to the work done, but to the quantity of it in the food, even when there is no muscular exertion.

That the chief functions of nitrogenous matters is to repair tissue there can be no doubt, for animals kept on a purely carbonaceous diet quickly lose weight, and at last die from a disintegration of tissue; but it is equally certain that the nitrogenous constituents of food have other offices to perform. A daily diet of 2 lbs. of bread contains enough nitrogen to supply the mechanical wants of the system, but it will not maintain life. There is required an addition of animal food to render it sufficient for this purpose; and indeed the instincts and habits of the human race show, beyond all question, that a comparatively rich nitrogenous diet is necessary for the proper sustenance of life; and it is very probable that it assists the assimilation of the hydrocarbons. In this way it may help in the development of force without itself contributing directly to it; and this may serve to explain the fact, that there is a relation between the amount of nitrogen contained in the food and the labour value of it. Carnivorous animals are not only stronger and more capable of prolonged exertion than herbivorous, but they are also fiercer in their disposition, as if force were superabundant. The bears of India and America, says Playfair, which feed on acorns, are mild and tractable, while those of the polar regions, which consume fish, are savage and untamable; and taking instances of people—the Peruvians whom Pizarro found in the country at its conquest, were mild and inoffensive in their habits, and they subsisted chiefly on vegetable food; whilst their brethren in Mexico, when found by Cortes, were a warlike and fierce race, and they fed for the most part on animal diet. The miners of Chili, who work like horses, also feed like them, for Darwin tells us that their common food consists of bread, beans, and roasted grain. The Hindoo navvies also who were employed in making the tunnel of the Bhoire Ghat Railway, and who had very laborious work to perform, found it impossible to sustain their health on a vegetable diet, and

being left at liberty by their caste to eat as they pleased, they took the common food of the English navigators, and were then able to work as vigorously. Abundant examples of this description—some of which will be further discussed as we proceed, may be cited in proof of the direct relation of plastic food to mechanical work; but there is no proof that this material must first form tissue before its dynamical power can be elicited.

It is, however, a remarkable fact that all forms of nitrogenous food have not the same nutritive value; the glutinous matters of barley and wheat, though almost identical in chemical composition, have very different sustaining powers. It is the same with muscular flesh and artificially prepared fibrin and gelatine. Magendie found that dogs fed solely for 120 days on raw meat from sheep's heads preserved their health and vigour during the whole of the time; but more than three times the amount of isolated fibrin, with the addition of much gelatine and albumen, were insufficient to preserve life.

We may conclude, therefore, that although the main functions of nitrogenous matters are to construct and repair tissue, yet they have manifestly other duties to perform of an assimilative, a respiratory, and force-producing quality which are far from being understood. What do we know, indeed, of the actual *modus operandi* of the nitrogenous ferments—ptyalin, pepsin, pancreaticin, &c., which are secreted so abundantly in the alimentary canal; or of the conjugate nitrogenous compounds which are present in the bile? and how far have we advanced in interpreting the functions of the nitrogenous constituents of tea, coffee, maté, guarana, cocoa, &c., which the instincts of mankind in every part of the globe have evidently chosen for some physiological purpose? The same may be said of the crystalline nitrogenous matters of soup—as creatin, creatinin, inosic acid, &c., which can hardly be regarded as foods, although they have powerful sustaining properties. But enough of this for the present; and before leaving this part of the subject, I would direct attention to the fact, that nitrogenous matters when oxidised in the animal body never yield up the whole of their potential energy, for, by being converted into urea, which is the chief product of their decay, there is at least a seventh part of their power lost in the secretion. It may be that this is a necessity arising out of the circumstance that if they were completely oxidised in the animal body and converted into carbonic acid, water, and nitrogen, the last-named gas would be unable to quit the system, because of its insolubility in the animal fluids.

Functions of Fat.—The hydrocarbons which go by the name of fat differ from other hydrocarbons, as sugar and starch, in the circumstance that the oxygen is never in sufficient quantity to satisfy the affinity of the hydrogen; and, therefore, fat is more energetic as a respiratory or heat-producing agent. Its power, indeed, in this respect is just twice and a half as great as that of starch or sugar; for 10 grains of it will, by combining with oxygen, develop sufficient heat to raise 23.2 lbs. of water 1° F.; and according to the deductions of both Joule and Meyer, this is equivalent to the power of raising 17,923 lbs. one foot high. In cold countries, where animal warmth is required, food rich in fat is always preferred; and the fat bacon of the English labourer contributes in no small degree to the production of mechanical force.

But besides this, fat serves important functions in the processes of digestion, assimilation, and nutrition. Ac-

According to Lehmann, it is one of the most active agents in the metamorphosis of animal matter; and this is seen not merely in the solution of nitrogenous articles of food during digestion, but also in the conversion of nutrient plastic substances into cells and masses of fibre. Elsässer long since observed that during the process of artificial digestion, the solution of nitrogenous foods was considerably accelerated by means of fat; and Lehmann has since determined, by actual experiment on dogs, that albuminous substances deprived of fat remain longer in the stomach and require more time for their metamorphosis than the same substances impregnated with fat. It is probable, indeed, that the digestive power of the pancreatic fluid is due in great measure to the presence of fat; and that the subsequent chymification of food, and its absorption into the blood, is greatly assisted by it. There is also good reason for believing that it is largely concerned in the formation of bile, and that the biliary acids are conjugated fatty compounds. This may account for the well-known action of fat bacon, and other such foods in promoting the secretion of bile.

The digestive power of fat is certainly considerable; and it is no less active in the subsequent conversion of nitrogenous matters into cells and tissues, and perhaps also in effecting their retrograde decay. Colourless blood-corpuscles receive perhaps the first impulse of their formation from the metamorphosis of fat; and thus it may be an important aid in the genesis of blood. It would appear, too, from the latest investigations of physiologists, that it plays an equally important part in every kind of cell development. Acherson showed, as far back as 1840, that albumen always coagulates from its solution around a fat globule, and this is seen in the little fatty particles of milk, which have a covering like a cell-wall of consolidated casein. Hünefeld, Nasse, and others, have further shown that the nucleoli of cells invariably consist of fat, and that recently-formed plasma always contains more fat than the mature cell. The conclusion, therefore, is that it takes an active part in all the processes by which the nutrient constituents of food are converted into the solid substrata of organs; and so energetic are its powers in this respect, that when the nitrogenous matters of the fluids are not in sufficient quantity to form cells with the fat, it borrows the material from muscular or other tissues, and thus produces a fatty degeneration of the part. This is observed in the muscular structures of over-fed animals, in the tissues of drunkards, who take a large amount of fat-forming food, and in the livers of geese that are crammed with a farinaceous diet.

And not only is it concerned in the formation of new tissue, but it also pervades, and finally disintegrates the older structures, especially when the vitality of them is low. In this manner it helps in the solution and subsequent removal from the animal body of decayed and morbid products of the protein type.

Again, its presence in large quantity in the tubules of nerves, and in the ganglionic centres, would indicate that it performs some highly important functions in nervous action.

And lastly, the distribution of it in the tissues, and the accumulation of it around certain organs, serve to fill up the vacuities of the body, to give rotundity to the form, to equalize external pressure, to diminish the friction of parts, to give suppleness to the tissues, and by its bad conducting property to retain the animal warmth. Fat, therefore, must always enter largely

into the composition of our food; for other hydrocarbons, though capable of transformation into fat, cannot entirely take its place.

3rd. *Starches and Saccharine Substances.*—These are well called hydrates of carbon, for the oxygen and hydrogen contained in them are nearly always in the proportion to form water. The carbon, therefore, is alone capable of oxidation, and according to Liebig their functions are entirely calorific or respiratory; but, like other heat-producing agents, they must also have mechanical power, for everything that will raise the temperature of a pound of water one degree of Fahrenheit will, by another modification of its action, raise 772 lbs. a foot high. The energies, however, of this class of substances are not nearly so great as with fats, for in the last case, as I have said, there is much available hydrogen, as well as carbon, for oxidation. The diagram which is before you will make this clear.

CALORIFIC AND MOTIVE POWERS OF 10 GRAINS OF THE SUBSTANCE IN ITS NATURAL STATE.

	Lbs. of water raised 1° F.	Lbs. lifted 1 ft. high.
Grape sugar.....	8.4	6,477
Lump sugar.....	8.6	6,617
Arrowroot.....	10.0	7,731
Butter.....	18.6	14,358
Beef fat.....	20.9	16,131

So that, in round numbers, the calorific power of fat is about twice as great as that of starch and sugar, and when dry it is twice and a half as great.

But these substances have other duties to perform besides the development of animal heat, which is, in fact, the final product of their oxidation, for on becoming changed into glucose by digestion they take the form of various acid compounds, as lactic acid, which occurs in the stomach and in the juice of flesh; butyric, formic, and acetic acids, which are found in the perspiration. The exact functions of these acids are not known to us, although, as I have already explained, the presence of lactic acid in the stomach is essential to the digestion of nitrogenous matters; and perhaps also its occurrence in the juice of flesh is for a similar object—viz., the solution of effete tissues.

Starches and sugars are also concerned in the production of fat. This was once the subject of an animated discussion by Liebig and Dumas, whose views of it were in complete antagonism; but the experiments of Boussingault, Persoz, Lawes, and others on the feeding of animals, have proved beyond all question that fat may be derived from the hydrates of carbon, and that therefore the views of Liebig were correct. Common experience, indeed, has fully taught us that foods which are rich in farinaceous matters and sugar are very capable of producing fat.

4th.—The saline or mineral constituents of food are largely concerned in the metamorphosis of matter; and, perhaps, this is their sole function. It is a specialty of these substances to give a soluble form to the plastic constituents of food, and of the animal tissues. They are, therefore, concerned in the phenomena of digestion, absorption, sanguification, assimilation, disintegration, and secretion. In truth, they are the chief, if not the only media for the transference of organic matter from place to place in the animal body—being, on one hand, the purveyors of nutrient materials into the system, and on the other, the carriers of effete substances out of it; besides which, it is very probable that they are the agents whereby liquid colloidal forms of nutriment are changed into solid or pectous, as in

the formation of solid tissues from the blood. In the case of digestion and absorption the plastic elements of our food, as albumen, fibrin, gelatin, &c., are not of themselves capable of dialysis, or of passing through the walls of the alimentary canal; and, therefore, absorption must be assisted by some physical agent. This agent is the highly diffusive acids and salts which are secreted so freely into the stomach during digestion; and it is very probable that they not only effect a solution of the proteinaceous matter of food, but, by converting it into peptones, as Lehmann expresses it, they also change the molecular form of the material, and make it pass from an unabsorbable colloid into a highly diffusive crystalloid. If, indeed, it be, as Mr. Graham supposes, that a colloid molecule is but a group of smaller crystalloids, the action of the saline and acid constituents of the gastric juice might be to break up the larger colloid molecule, and thus give it the property of diffusion and absorption. An opposite condition of things would occur in the alkaline blood, whereby the colloid molecule would regain its structure, and lose its diffusive tendency; but, coming to the tissues, where an acid condition of the fluids again exists, it once more changes its molecular structure, and quits the blood to serve the purposes of nutrition. The exact nature of the phenomena that occur when the liquid nutrient matter which thus escapes is changed into solid tissue is unknown to us; but there is good reason for believing that it is no more than a molecular movement effected by the agency of saline matter. In the case of certain structures which contain more than a common amount of mineral salts, this is unquestionably so, for it occurs in the consolidation of the spicula of sponges, the calcareous tissues of polypes, the hard dermal structures of the radiata, molusca, crustacea, &c., and in the calcareous deposits of bone, teeth, tegumentary scales, egg-shells, &c. of the vertebrata. In all these instances the secreted matter must first have been crystalloidal, or it could not have been secreted; it then takes the form of a liquid colloid or jelly; and finally, by a further molecular movement, it passes into the condition of a pectous solid—the saline constituents, according to their nature and proportion, determining the degrees of hardness.

Again, the removal of effete matters and worn-out tissues is undoubtedly effected by the agency of saline substances; for, during the processes of oxidation, acid compounds are produced, which, by acting chemically on the saline constituents of the animal fluids, give them a solutive power on plastic matters, and thus enable them to remove the *débris* of worn-out tissue.

As to special functions of the several saline constituents of food, little can be said; but it is a remarkable fact that the alkaline or basic phosphate of soda is invariably found in the blood, while acid phosphate of potash is the chief constituent of the juice of flesh. Most likely the former is concerned in pre-erving the liquid colloidal condition of albumen and fibrin, and so keeping them from being lost by secretion, while the latter is engaged in an opposite duty. The alkalinity of the blood also helps in the oxidation of organic matters; and as the basic phosphate of soda is endowed, like an alkaline carbonate, with the power of absorbing carbonic acid, it is the chief agent whereby this compound is removed from the system. This is a remarkable property, and is one of the chief uses of basic phosphate of soda in the blood. In point of fact, when it is not there in sufficient quantity to perform this function, it is replaced by an alkaline carbonate. We find this

to be so in the blood of herbivorous animals, where the proportions of the two salts are the reverse of what they are in man and carnivora. Some notion may be formed of the relative importance of the saline matters of the blood by reference to this diagram from Liebig.

PERCENTAGE COMPOSITION OF THE MINERAL MATTERS OF BLOOD.

	Man.	Hg.	Dog.	Powl.	Sheep.	Ox.
Phosphoric Acid.....	31.79	36.50	36.82	47.26	14.30	14.04
Alkalies.....	65.66	49.30	55.24	48.41	55.79	60.00
Alkaline Earths.....	3.33	3.30	2.07	2.22	4.57	3.64
Mineral Acids and Oxide of } Iron.....	9.22	9.90	5.87	2.11	24.54	22.32
Total.....	100.00	100.00	100.00	100.00	100.00	100.00

And in those cases where the phosphoric acid is deficient, it is replaced by carbonic acid. In man, for example, the quantity of combined carbonic acid in the ashes of the blood is only 3.78 per cent, whereas in the calf it is 9.85, and in the sheep 19.47 per cent, so that in all cases the alkalinity of the blood remains the same.

The salts of potash in the juice of flesh have, no doubt, an equally important duty to perform, although of an opposite character; for while the alkaline phosphate of soda in the blood prevents the transudation of nutrient matter, the acid phosphate of potash in the muscular fluid promotes it; and thus it is concerned in nutrition and in the solution of worn-out tissues.

Earthy phosphates, especially phosphate of lime, are, perhaps, the agents for the consolidation of tissue; for not only are they present in the hard structures of the body, as the bones and teeth, but they also enter into the composition of flesh.

And not less important in the morphological functions of the animal body is the presence of common salt. It is a large constituent of every one of the secretions, and forms about half the total weight of the saline matters of the blood. Unlike the phosphates, however, it does not enter into the composition of tissue, but seems to be only a medium of absorption and secretion; and so necessary is it for this purpose, that it is not possible to alter, to any large extent, its proportion in the blood. If we drink water containing but little common salt in solution, it does not permanently dilute the blood, but passes off immediately by the kidneys; and if we try to increase the amount in the blood by drinking solutions of salt, as sea water, it refuses to be absorbed. This normal proportion of it in the blood is evidently a physiological necessity, which the conditions for diffusion imperatively demand. It is a curious fact, also, that common salt has the faculty of forming crystallisable compounds with most of the unorganised and effete constituents of the body. May it not, therefore, be an important agent of diffusion, and be thus concerned in the phenomena of absorption and secretion; for as colloidal matters—albumen and fibrin—cannot pass through the walls of the intestines, or the blood-vessels, it may well be that through the agency of common salt and the free acid of the gastric and muscular juices, they temporarily assume a crystalloidal condition, and are thus absorbed or secreted.

The constant presence of common salt in the secretions, and the necessity for it in due proportion in the blood, indicate the importance of a proper supply of it with the food. We perceive this in the instinct of animals, and in our own craving for it when it does not exist in sufficient quantity in the food. Animals, in fact, will travel long distances, and brave the greatest dangers, to obtain it. Men will barter gold for it; in-

deed, among the Gallas, and on the coast of Sierra Leone, brothers will sell their sisters, husbands their wives, and parents their children, for salt. In the district of Accra, on the Gold Coast of Africa, a handful of salt is the most valuable thing upon earth after gold, and will purchase a slave or two. Mungo Park tells us that with the Mandingoes and Bambaras the use of salt is such a luxury that to say of a man "he flavours his food with salt," is to imply that he is rich; and children will suck a piece of rock-salt as if it were sugar.

The experiments of Boussingault have shown that, although salt mixed with the fodder of animals does not much affect the quantity of flesh, fat, or milk obtained from them, yet it seriously affects their appearance and general condition; for animals deprived of salt, other than that contained naturally in the food, soon get heavy and dull in their temperament, and have a rough and staring coat. Reulin states that animals which do not find it in their food or drink, become less prolific, and the breed rapidly diminishes in number. This is confirmed by Dr. Le Saine, who says, in his prize-essay on salt, that it increases the fertility of the male and the fecundity of the female, and it doubles the power of nourishing the foetus. During the period of suckling, also, salt given to the mother renders the milk more abundant and more nutritious. It likewise accelerates growth, and gives a finer condition to the skin; and the flesh of animals fed with it is better flavoured and more easily digested, than that of animals which do not partake of it. In barbarous times, the most horrible of punishments, entailing certain death, was the feeding of culprits on food without salt; and in the experiments of the French Academicians, flesh deprived of its saline constituents by being washed with water, lost its nutritive power, and animals fed on it soon died of starvation. Even after a few days, with such a diet, the instincts of the animals told them it was worthless as food; indeed, for all purposes of nutrition, it was, as Liebig says, no better than the eating of stones, and the utmost torments of hunger were hardly sufficient to induce them to continue the diet. There was plenty of nitrogenous matter in the food, but there was no medium for its solution and absorption, and hence it was useless.

The oxides of iron, and their homologues, the oxides of manganese, are largely concerned in the processes of sanguification and oxidation. They enter into the composition of the globules of the blood—manganese being the chief mineral constituent of the corpuscles of white-blooded animals, and iron of red. In fact, the colouring-matter of the blood discs (crucrin), as well as that of the muscles (myochrome), is a compound of iron and albumen (globulin), which has a remarkable property of absorbing oxygen when exposed to the air, and of giving it out again in the presence of reducing agents. In the one case it acquires an arterial tint, and in the other a venous; and the spectrum informs us that these two conditions of it are easily assumed—one by the presence of atmospheric oxygen, and the other by decaying organic matter. It is hardly to be doubted that these are the conditions of it in blood—the bright red oxidised crucrin being the form of it in arterial blood, and the dark reduced variety of it in venous. The functions, therefore, of both crucrin and myochrome are entirely of a respiratory nature; for in the former case it is the medium whereby oxygen is absorbed from the air in the lungs, and is carried with the blood-discs throughout the body, and in the latter it may be the agent of interstitial oxidation.

Lastly, there is a mineral constituent of our food, silica, which enters into the composition of all the tegumentary appendages. Its presence is not of so much importance to us as to the lower animals, whose warmth is retained by a natural covering of hair, or wool, or feathers. In the case of birds, indeed, the quantity of silica in the feathers is very considerable, and Gorup-Besanez has described its physiological relations.

As to the proportions of mineral substances required in the food, it is difficult to speak. Dr. Edward Smith says that an adult man requires daily from 32 to 79 grains of phosphoric acid; from 51 to 175 grains of chlorine (equal to from 85 to 291 grains of common salt); from 27 to 107 grains of potash; from 80 to 171 of soda; from 2.3 to 6.3 of lime; and from 2.5 to 3 of magnesia. According to Mr. Lawes, a very small portion of these salts is retained in the system; for in fattening pigs he found that of every 11 lbs. of mineral matter contained in the food only 12 ozs. were stored up in the body, and this was chiefly the earthy phosphates, all the rest being either unabsorbed, or else used in the work of absorption, assimilation, and secretion. In most cases, therefore, there is sufficient saline matter, excepting common salt, in all ordinary food; but for all this, the presence of it in the water we drink is not an unimportant question. Four-fifths of the earth's surface are composed of calcareous strata, which yield water that is more or less rich in carbonate or sulphate of lime; and it may well be that this is a wise provision for the supply of these salts to the animal system. As Mr. Johnston has truly observed in his "Chemistry of Common Life," "The bright sparkling hard waters which gush out in frequent springs from our chalk and other lime-stone rocks are relished to drink, not merely because they are grateful to the eye, but because there is something exhilarating in the excess of carbonic acid they contain and give off as they pass through the warm mouth and throat; and because the lime they hold in solution removes acid matters from the stomach, and thus acts as a grateful medicine to the system. To abandon the use of such a water, and to drink daily in its stead one entirely free from mineral matter, so far from improving the health, may injure it;" in fact the water of a country may determine the diet of its inhabitants. The soft waters of the lakes of Scotland, for example, may have had something to do with the choice of brown meal; and but for the calcareous waters of Ireland the potato could not have become a national food.

And now, before I leave this part of the subject, it is right that I should say a few words respecting the functions of certain beverages (as tea, coffee, and fermented liquors), which have been more or less in use in all ages, as if from an untaught physiological instinct. Vegetable infusions, containing the same active principles—viz., astringent matter, volatile oil, and a crystallisable body rich in nitrogen, have been resorted to for some undefined purpose by the natives of every climate; indeed, to use the words of Mr. Johnston, "the practice has prevailed equally in tropical and in arctic regions. In Central America, the Indian of native blood, and the Creole of mixed European race, indulge alike in their ancient chocolate. In Southern America the tea of Paraguay is an almost universal beverage. The native North American tribes have their Appalachian tea, their Oswego tea, their Labrador tea, and many others. From Florida to Georgia in the United States, and over all the West India Islands, the natural-

ised European races sip their favourite coffee; while over the Northern States of the Union, and in the British provinces, the tea of China is in daily and constant use.

"All Europe, too, has chosen its prevailing beverage; Spain and Italy delight in chocolate; France and Germany, and Sweden and Turkey, in coffee; Russia, Holland, and England, in tea—whilst poor Ireland makes its warm drinks of the husks of the cocoa, the refuse of the chocolate mills of Italy and Spain.

"All Asia feels the same want, and in different ways has long gratified it. Coffee, indigenous in Arabia or the adjoining countries, has followed the banner of the prophet, wherever in Asia or Africa his false faith has triumphed. Tea, a native of China, has spread spontaneously over the hill country of the Himalayas, the table lands of Tartary and Tibet, and the plains of Siberia; has climbed the Altai, overspread all Russia, and is equally despotic in Moscow as in St. Petersburg. In Sumatra, the coffee-leaf yields the favourite tea of the dark-skinned population; while Central Africa boasts of the Abyssinian chaat as the indigenous warm drink of its Ethiopian people. Everywhere, in fact, unintoxicating and non-narcotic beverages are in general use among tribes of every colour, beneath every sun, and in every condition of life. The custom, therefore, must meet some universal want of our nature, some physiological function which science has not yet explained; and, considering that these beverages contain essentially the same chemical compounds, it is remarkable that they should have been selected from the whole range of the vegetable kingdom." As Mr. Johnston truly observes, "What constitutional cravings common to us all have prompted to such singularly uniform results! Through how vast an amount of unrecorded individual experiences must these results have been arrived at!"

The principal constituents of these vegetable substances are—

1st. A volatile oil, on which their aroma depends, and which rarely amounts to one part in 150. 2nd. An astringent acid, of the nature of tannic acid in tea, and called caffeic acid in coffee, which give them their bitter styptic taste; it amounts to from 13 to 18 per cent in tea, and to about 5 per cent in coffee; and 3rd, a crystallized nitrogenous substance of an alkaline nature called theine or caffeine, and theobromine. The average amount of this alkaloid in different vegetable substances, according to Dr. Stenhouse, is here recorded:—

	Theine or Caffeine per cent.
Guarana, or Brazilian cocoa from <i>Guarana officinalis</i>	5.07
Good black tea	2.13
Black tea from Kemaon, E. I.	1.97
Dried coffee leaves	1.26
Maté, or Paraguay tea, from <i>Ilex Paraguaysis</i>	1.20
Various samples of coffee-beans from 0.8 to 1.00	

The physiological properties of this substance, and of its homologue, theobromine, are not clearly discoverable. Mulder states that they are not the agents concerned in the peculiar action of tea and coffee. Liebig, however, points to the fact that with the addition of oxygen and the elements of water they can yield taurine, which is the nitrogenized constituent of bile; and he asks whether they may not be concerned in the production of bile. Theine, he also states, is related to kreatinine—that remarkable compound, produced in the vital process, and occurring in the muscular system of animals; and to glyocol, which we

may suppose to exist in gelatine coupled with another compound. In fact, according to him, there are no drinks which in their complexity, and in the nature of certain constituents, have more resemblance to soup than tea or coffee; and it is very probable, he says, that the use of them as a part of food depends on the exciting and vivifying action which they have in common with soup. Reasoning in this way, it may be said that theine or caffeine, and theobromine, are closely related in their composition to nervous tissue, and that therefore they are suited for the repair and renovation of the exhausted brain. Experiments made by Lehmann, in 1854, with infusion of roasted coffee, and with caffeine, went to show that their chief influence on the human body was to retard the waste of tissues; that when, for example, an infusion of three-quarters of an ounce of roasted coffee was taken daily for a fortnight, the amount of urea and phosphoric acid excreted by the kidneys was less by one-third than when the same food was taken without the coffee. The empyreumatic oil was found to exert a stimulating action on the nervous system, and when taken in excess caused excitement and wakefulness. It also operated on the skin by producing a gentle perspiration, and it removed the sensation of hunger. The conclusion from these experiments was, that both tea and coffee exhilarate the nervous system, and, by lessening waste, enable the food to go further in its nutritive action; that with a given quantity of food more work could be performed when these beverages were taken than otherwise; and that in old, infirm persons, where the desire for tea is so strong, the waste and decay of the system was lessened. It operates, in fact, as a sort of lubricant of the animal system, and by oiling the machinery, enables it to work easier and longer.

The more recent experiments of Dr. Edward Smith are not exactly to the same purpose; for, in his opinion, tea promotes rather than checks the chemico-vital functions of the body, for directly after it is taken, the quantity of carbonic acid emitted from the lungs and the quantity of air inspired are increased; and there is greater depth and freedom of respiration. In this way, he thinks, it promotes the transformation of starchy and fatty food; besides which, it increases the action of the skin, and by inducing perspiration lessens the heat of the body. Coffee, he says, has an opposite effect, for it lessens the action of the skin, and promotes that of the bowels; and its influence on the respiratory processes is somewhat less than that of tea.

It is manifest from all this that we have yet to learn what are the special actions of these beverages; and why it is that they have been used in all times, and in all countries, as a means of supplying some natural want which science is unable to discover—that everywhere, the poor and the needy, the aged and the infirm, will make a sacrifice of even nutritious food for some such beverage as tea and coffee—that not less than 500,000,000 of the human race should make use of an infusion of tea; that more than 100,000,000 should drink coffee; about 50,000,000 cocoa; and not less than 10,000,000 of the inhabitants of Peru, Paraguay, and the Brazils should use an infusion of maté or guarana. In this country alone there is over 100,000,000 lbs. of tea consumed annually, and perhaps about half as much of coffee. All this looks like the influence of some deep-seated necessity which our philosophy is unable to fathom.

And with regard to the use of fermented liquors, there is the same universal indication of their serving a profound physiological purpose, and supplying a com-

mon want. It is no argument that, because these things have been abused, they serve no purpose in man's economy. On the contrary, the fact of their use in all time, and that no saccharine liquid or juice of ripe fruit can be exposed to the air without spontaneous and almost immediate fermentation, are striking evidences of a useful purpose. They may not enter into the composition of tissues, but they may stimulate the energies of the living frame, and rouse them into increased activity. It is not merely the brick-work and marble, so to speak, of the human body, nor yet the concrete movements of the machine, that have to be sustained, for there are rarer forms of matter, and higher manifestations of force, concerned in man's existence; and his resort to such beverages as these may be for something more than the nourishment of the system, or even the mere raising of his spirit above the common concerns of this work-o'-day world.

That alcohol stimulates the action of the nervous system there is no doubt, and it is equally certain that it increases the respiratory changes. Dr. Edward Smith is of opinion that it also lessens the action of the muscles which are subject to volition, and increases, in a certain degree, the action of those which are independent of it, as the heart and respiratory muscles. He finds, too, that it diminishes the functions of the skin, and by thus lessening the waste of animal heat, it has a conservative tendency. The effects of alcohol are, however, much modified by the substances with which it is associated in different alcoholic liquids—beers and ale, for example, act on the respiratory functions by reason of the saccharine and nitrogenous matters they contain; wine also, as well as cider and perry, have a similar action, and in proportion to their saccharine and acid constituents; brandy and gin lessen the respiratory changes, and the latter acts on the kidneys by reason of the volatile oil it contains; whiskey is uncertain in its effect upon the lungs; while rum, like beer and ale, is a true restorative, as it sustains and increases the vital powers; and he says that the old-fashioned combination of rum and milk is the most powerful restorative with which he is acquainted.

Liebig is of opinion that alcohol is burnt or oxidised in the system, and is therefore a calorific agent; but the researches of Lallamand, Perrin, and Duray, as well as those of Dr. Edw. Smith, have demonstrated that a large portion of it passes through the system unchanged, and appears in the breath and perspiration, as well as in the urine. They, therefore, conclude that alcohol is not a food, but is a mere excitant of the nervous centres. On the other hand, Dr. Thudicum in a rather large experiment on the students of his class (33 in number), found that of the 4,000 grammes of alcohol in the 44 bottles of wine which they drank at one sitting, only 10 grammes appeared in the urine; and assuming that about 10 grammes more were exhaled by the breath and skin, he concluded that only 0.5 per cent of the alcohol escaped unchanged. He therefore believes that alcohol is oxidised in the body, and is a true food.

But besides this, the inquiries of Poisseuille have shown that it is a physical as well as a chemical and physiological agent, for it hinders the flow of liquids in narrow tubes, and may act in the same way on the movements of the blood in the capillary vessels. He found, for example, that when the flow of a certain quantity of water through a small tube occupied 575.8 minutes, and of the serum of blood 1048.5 minutes, the flow of the same quantity of Madeira wine under the same circumstances was 1138 minutes, of sparkling Sil-

lery 1463, and of Jamaica rum 1832. Its functions, therefore, are manifestly of a complicated nature; in fact, the whole subject is remarkably obscure, and requires the light of science to illuminate it. As in the case of tea and its allies, ages of empiricism are waiting for a philosophical interpretation.

Lastly, as to the functions of condiments—as peppers, mustard, spices, &c. They are merely stimulants of the digestive organs, promoting the flow of the saliva, the gastric juice, and other intestinal secretions; and increasing the peristaltic movements of the viscera. They thus aid in the processes of digestion; and by giving flavour to the food, they whet the appetite, and so increase the relish for it—indifferent food is thus made palatable, and its digestion accelerated.

And now, in conclusion, we may safely inquire, as a supplementary question to the functions of food, what are the mechanical and thermotic powers, as well as the fattening capabilities of various articles of diet?

Dr. Frankland has made some very careful determinations of the calorific values of different substances used as food; and remembering that every pound of water raised 1° of Fahrenheit represents a mechanical force of 772 lbs. lifted a foot high, it is easy to calculate the working energy of any substance from its thermotic power when burnt in oxygen, or when less perfectly consumed in the animal body. Arranging the results under these two heads, we shall find that the energies of different articles of diet may be expressed as in the following table:

ACTUAL ENERGY OF TEN GRAINS OF THE MATERIAL, IN ITS NATURAL CONDITION, WHEN COMPLETELY BURNED IN OXYGEN, AND WHEN OXIDISED INTO CARBONIC ACID, WATER, AND UREA, IN THE ANIMAL BODY.

	Per cent of water in Material.	Lbs. lifted 1 foot high. When burnt in Oxygen.	When Oxidised in the body.
Butter.....	15	14357	14357
Cheshire Cheese.....	24	9187	8613
Oatmeal.....	15	7913	7769
Wheat flour.....	15	7788	7591
Pea-meal.....	15	7778	7456
Arrowroot.....	18	7731	7731
Ground rice.....	13	7535	7424
Yolk of egg.....	47	6761	6532
Lump sugar.....	19	6616	6616
Grape sugar.....	20	6476	6476
Entire egg.....	62	4708	4507
Bread crumb.....	44	4409	4246
Ham.....	54	3915	3317
Mackerel.....	71	3537	3187
Lean beef.....	71	3098	2818
Lean veal.....	71	2594	2314
Guinness's stout.....	88	2123	2123
Potatoes.....	73	2002	1969
Whiting.....	80	1787	1563
Bass's ale.....	88	1530	1530
White of egg.....	86	1325	1138
Milk.....	87	1306	1241
Carrots.....	86	1040	1026
Cabbage.....	89	858	830

It will be understood of course, that to obtain these results in the animal body the materials must be completely absorbed, and fully oxidised into carbonic acid, urea, &c.

Estimated in this manner, it may be said that a daily subsistence diet of 2 ozs. of dry nitrogenous food, 13.2 ozs. of dry carbonaceous, calculated as starch, and a daily working diet of 6 ozs. of dry nitrogenous food, and 26 ozs. of dry carbonaceous, have the folloiwed mechanical energies:—

	Lbs. lifted 1 foot high.	
	When burnt in oxygen.	When oxidised in the body.
Subsistence diet.....	6,319,783	6,307,078
Working diet.....	13,349,405	13,311,290

But the actual working power of the human body does not approach this. In fact, although a man's daily labour has a very large range, as from 300,000 ft.-lbs. when lifting dung into a cart to 1,500,000 ft.-lbs. when pushing or pulling horizontally, yet the average is not above 1,000,000 ft.-lbs., as will be seen from this diagram:—

Kind of labour.	Amount of work in ft.-lbs.	Authority.
Bricklayer's labourer carrying bricks.....	1,627,200	Mayhew.
Coal whipping.....	1,293,600	"
Ascending Faulhorn.....	1,074,931	Wislicenus.
".....	933,746	Fick.
Treadmill.....	1,008,000	Mayhew.
".....	861,156	Ed. Smith.
Turning a winch.....	837,760	Coulomb.
Pedestrians (20 miles a day)....	792,000	Haughton.
Paving and pile-driving.....	788,480	Coulomb.
Porters carrying loads.....	732,480	"
Shot-drill punishment.....	694,400	Haughton.
Average.....	968,614	

And even when we add the calculated internal work of a man's body, as the beating of the heart and the movements of respiration, the total of it does not much exceed a million and a half foot-pounds a day:—

	Foot-pounds.
External work or actual labour.....	967,614
Work of circulation (75 beats a minute).....	497,880
Work of respiration (15 a minute).....	98,064

Total ascertainable work per day..... 1,563,558

It is evident, therefore, that a large portion of our food must escape digestion and absorption; indeed, the thermic power of the food actually consumed daily, as estimated by the carbonic acid exhaled and the urea secreted, is not more than sufficient to raise the temperature of 10,000 lbs. of water 1° of Fahrenheit. This is equal to a force of 7,720,000 lbs. lifted a foot high; so that the ascertainable work of the food is about one-fifth of its actual energy, the rest of the power being consumed in molecular movements within the animal body. Helmholtz asserts that the external work should be a fifth part of the mechanical force of the digested food; but labour must be well applied to develop this proportion of its energy.

In the steam-engine, according to Sir William Armstrong, only a tenth part of the actual power of the fuel is realized as work. The human machine is therefore more economical of its force than a steam-engine; in fact, it is assumed by Heidenham and others that not less than half of the force applied to the living muscles, as it is developed in their tissue, is utilized. But although the animal machine is so much more economical of force than the steam-engine, yet on account of the costliness of its fuel, &c., it is far more expensive. Taking, for example, a steam-engine of one-horse power (that is, a power of raising 33,000 lbs. a foot high per minute), it will require two horses in reality to do the same work for ten hours a day, or twenty-four men; and the cost would be 10d. for the steam-engine, 8s. 4d. for the two horses, and just £2 sterling for the twenty-four men.

Dr. Frankland has estimated the weight and cost of various articles of food required to be oxidised in the animal body in order to raise 140 lbs. (a rather small

man) to the height of 10,000 feet, supposing that only one-fifth of the actual energy of the food is manifested as external work. Here is a part of his table:—

	Ounces required.	Cost.
Oatmeal.....	20'5	0 3½
Flour.....	21'0	0 3½
Pea-meal.....	21'4	0 4½
Bread.....	37'5	0 4½
Potatoes.....	81'1	0 5½
Rice.....	21'5	0 5½
Beef-fat or dripping.....	8'9	0 5½
Cheshire cheese.....	18'5	0 11½
Cabbage.....	192'3	1 0½
Butter.....	11'1	1 0½
Hard-boiled eggs.....	35'3	1 2½
Lump sugar.....	24'1	1 3
Milk.....	128'3	1 3½
Lean beef.....	56'5	3 0½
Guinness's stout.....	64 bottles	5 7½
Bas's pale ale.....	9 do.	7 6

The motive-power of fatty foods is thus shown to be far higher than that of lean meat or farinaceous substances, and this accords with experience, for the labouring classes have long since discovered that fat bacon is a good material for heavy work. Its efficacy may, in great part, depend on the ease and certainty with which it is digested and utilised in the body.

The fattening functions of food are liable to great variation, not merely from the quality of the food itself, but from the peculiarity of the individual consuming it. This is a matter of common observation, and is well known to the breeders of stock. Messrs. Lawes and Gilbert found in their experiments on the feeding of bullocks, sheep, and pigs, that very different quantities of food were required to produce the same increase of weight. Oxen and sheep, for example, feeding on the same diet—viz., oil-cake, hay, and turnips—consume, in one case (that of oxen), 1,109 lbs. of dry substance for every 100 lbs. of increase in the live weight, while in the other the sheep consume only 912 lbs.; and pigs fed on barley-meal will fatten to the same extent on 420 lbs. of the dry material. Pigs, therefore, store up about one-fourth of their food, reckoned in this way; sheep about one-ninth; and oxen only one-eleventh.

The proportions of the several constituents of the food are also very differently used by these animals; for in every 100 parts of the dry food eaten, the several amounts of nitrogenous, carbonaceous, and mineral matters are thus disposed of:—

CONSTITUENTS OF THE DRY FOOD.		Proportions in dry food.	Proportions stored in animal.	Proportions in manure.	Proportions lost in respiration.
Oxen	{ Nitrogenous.....	19'66	0'8	29'1	57'3
	{ Carbonaceous.....	72'86	5'2		
	{ Mineral.....	7'48	0'2		
		100'00	6'2	36'5	57'3
Sheep	{ Nitrogenous.....	19'41	0'8	25'1	60'1
	{ Carbonaceous.....	73'57	7'0		
	{ Mineral.....	7'02	0'2		
		100'00	8'0	31'9	60'1
Pigs	{ Nitrogenous.....	12'38	1'7	14'3	65'7
	{ Carbonaceous.....	85'00	15'7		
	{ Mineral.....	2'62	0'2		
		100'00	17'6	16'7	65'7

So that the power of appropriation is greatest with pigs and least with oxen; in fact, of every 100 lbs. of the several constituents of the food, the following are proportions stored up in the three classes of animals:—

	Pigs.	Sheep.	Oxen.
Of 100 Nitrogenous.....	13.5	4.2	4.1
Of 100 Carbonaceous.....	18.5	9.4	7.2
Of 100 Mineral.....	7.3	3.1	1.9

It will be noticed, too, that the proportions lost in respiration are very different in the three cases; for it is greatest in the pig—amounting to nearly 66 per cent. of all the food eaten, and least in the ox, 57.3 per cent. These proportions represent the vital work of the body during the processes of growth and repair.

The time also that is occupied in producing fat and muscular tissue is different with these animals, for the pig increases from 6 to 6.5 per cent of its weight per week; the sheep not more than 1.75 per cent; and the ox only 1 per cent. Some of this difference is doubtless due to the quality of the food made use of, for the pigs were fed on a nutritious and easily digestible diet—oatmeal; while the sheep and oxen made use of food with a large quantity of cellular tissue and woody fibre; and here I may remark that the power of utilising the inferior varieties of food is very different with different classes of animals. Man, as I have already explained, is unable to digest woody fibre, or even the harder kinds of cellulose; it is doubtful, indeed, whether he can digest cellulose at all. The pig, also, has but a limited capacity for this kind of work; whereas oxen and sheep, and the herbivora generally, can eat woody tissues with advantage, and convert them into flesh and fat. In eating meat, therefore, we are utilising the digestive powers of other animals; and are, in fact, employing their stomachs to do for us that which we could not do for ourselves. This, as Mr. Lawes says, is proved, not merely by the testimony of common experience, but also by certain anatomical facts relating to the structure and comparative size of the stomach in different animals. In oxen, for example, the stomach weighs 51 ozs., for every 100 lbs. of live weight; in sheep it weighs 39 ozs.; in pigs 14 ozs.; and in man only 6 ozs. It is manifest, therefore, that the food of man should be more concentrated than that of the lower animals; and that he acts wisely in eating flesh and fat, which are the very essence of food, for he thereby economises labour, and employs the assimilative powers of other creatures to bring the crudest materials into a nutritious and highly digestible form. It is true that man, in common with other animals, is able to convert starch and sugar into fat, and the lower qualities of albumen into flesh, but by so doing he expends force, for in the case of fat he locks up in it twice and a half the potential energy of sugar and starch.

Looking broadly, therefore, at the functions of food, and regarding the animal body as a machine, in which potential energy is rendered active, it would appear that its main duty is to develop force by the oxidation of carbo-hydrogen contained in the blood, and not by the oxidation of tissue. A portion of tissue no doubt decays in the transference of its energies to other forms of action, and requires repair; but the decay is scarcely more rapid at one time than another, and is in no case, when sufficient food is employed, the cause of mechanical labour. "In man," says Dr. Frankland, "the chief materials for muscular power are non-nitrogenous; but nitrogenous matter can also be employed for the same purpose, and hence the greatly increased evolution of nitrogen under the influence of a flesh diet, even

with no increase of muscular exertion. The non-nitrogenous matters, also, which find their way into the blood, yield up all their potential energy as actual energy; whereas the nitrogenous in leaving the body as urea carry with them a portion (at least one-seventh) of their potential energy unexpended. The transference of potential energy into muscular power is necessarily accompanied by the production of heat within the body, even when the muscular power is exerted externally. This is, doubtless, the chief, and probably the only source of animal heat."

Construction of Diets: Preparation and Culinary Treatment of Foods.

THE construction of diets involves a variety of considerations, as—1st. The determination of the real wants of the body under different circumstances of age, sex, constitution, labour, and climate; 2d. A proper selection of food, as regards quality, nutritive power, appetising property, digestibility, and price; 3d. The association of foods in such wise as not to offend the appetite or burden the digestive powers; 4th. A right treatment of them by cooking, &c., so as to render them most useful to the system; and 5th. A just distribution of the daily diet in appropriate meals.

As regards the first question—viz., the determination of the actual dietetical wants of the body—it may be answered from two sets of facts, as those which pertain to the minimum quantities of food capable of being used without loss of health or bodily vigour, and those which relate to the amounts of carbon and nitrogen exhaled from the body during different conditions of life.

In a general way it may be said that a healthy vigorous man consumes from 700 to 800 lbs. of solid food (dry) in a year. This amounts to about 2 lbs. of dry solid matter daily; and the quantity of water (free and combined) is about 5½ lbs. daily.

Pursuing the inquiry a little farther, we find that a man cannot live on a punishment prison diet of 1 lb. of bread a day with water, for in three days he will lose about 3 lbs. in weight, and will show signs of commencing starvation. This diet contains 1.3 ozs. of nitrogenous matter and 8.42 of carbonaceous (= 1.995 grains of carbon and 90 of nitrogen). Even the poor needle-women of London can only just exist, in a state of feeble vitality, with an average diet of 1½ lbs. of bread a day, with about 1 oz. of dripping. This contains nearly 2 ozs. of nitrogenous matter, and 14.65 of carbonaceous, calculated as starch (= 3,271 grains of carbon and 135 of nitrogen). And in military prisons, where as much as 3.8 ozs. of nitrogenous food, and 22.2 ozs. of carbonaceous (= 6,925 grains of carbon and 256 of nitrogen), are supplied daily to prisoners for short terms of confinement, they frequently lose weight and give evidence of decay; so that for longer periods of imprisonment it is found necessary to increase the diet to 4.7 ozs. of plastic matter and 27.8 of respiratory (= 8,647 grains of carbon, and 317 of nitrogen); in fact, according to Dr. Christison, the men confined in the prison at Perth cannot even do the work of pumping the water for the prison on a daily diet of 6 ozs. of plastic matter, and 25 of respiratory (= 7,239 grains of carbon and 405 of nitrogen).

Again, Dr. Edward Smith found in his inquiries into the dietaries of adult male operators of Lancashire and Cheshire, during the cotton famine, and also into those of the low-fed operatives of England, that the daily amount of food, only barely sufficient for existence,

must contain 2.84 ozs. of nitrogenous matter, and 19.25 of carbonaceous (= 4,300 grains of carbon and 200 of nitrogen). These are contained in 2 lbs. 3 ozs. of bread, which is regarded as a famine diet. The farm labourers of England consume daily an average of 3.18 ozs. of plastic matter and 26.01 of respiratory. In Scotland, Wales, and Ireland, the amounts are somewhat larger, as will be apparent from this diagram:—

AVERAGE DAILY DIET OF FARM-LABOURERS IN THE UNITED KINGDOM.

	Dry Nitrogenous matter. ozs.	Dry Carbonaceous matter. ozs.	Carbon. grs.	Nitrogen. grs.
In England.....	3.18	26.01	= 5810	228
In Wales.....	4.12	31.22	= 6901	290
In Scotland.....	4.76	31.34	= 6297	335
In Ireland.....	4.94	28.73	= 6195	348
Average of all.....	4.25	29.07	= 6477	300

These are the results of inquiries into the dietaries of many hundreds of families, the results being computed as for adults; but it is very probable, as Dr. Smith remarks, that the nourishment obtained by the labourer himself is somewhat above the average. This, in fact, is confirmed by the more extensive investigations of Dr. Lyon Playfair, who concludes, from a large series of observations, that the following may be regarded as the average proportions of the several constituents of food in the daily dietary of an adult man under different circumstances of an existence:—

DAILY DIETS FOR	Flesh-former. ozs.	Fat. ozs.	Starch and Sugar. ozs.	Nitrogenous. ozs.	Carbonaceous, calculated as starch. ozs.
Subsistence only....	2.0	0.5	12.0	= 2.0	+ 13.2
Quietude.....	2.5	1.0	42.0	= 2.5	+ 14.4
Moderate exercise..	4.2	1.8	18.7	= 4.2	+ 22.0
Active labour.....	5.5	2.5	20.0	= 5.5	+ 26.0
Hard work.....	6.5	2.5	20.0	= 6.5	+ 26.0

These conclusions accord pretty well with the determinations of Pettenkofer and Voit, who say that an adult requires daily, when at work, 5.22 ozs. of nitrogenous matter and 22.38 of carbonaceous (calculated as starch). Taking, therefore, the mean of all these researches, it may be said that a man requires daily the following amounts of carbonaceous and nitrogenous matter for idleness, for ordinary labour, and for active labour:—

DAILY DIETS FOR	Nitrogenous. ozs.	Carbonaceous. ozs.	Carbon. grs.	Nitrogen. grs.
Idleness.....	2.67	16.83	= { 3,856	187
Ordinary labour....	4.56	24.48	= { 5,757	319
Active labour.....	5.81	24.31	= { 5,837	400

By pursuing the second method of inquiry, and estimating the wants of the body from the amounts of carbon and nitrogen exhaled and secreted, it is found that the proportion of carbon evolved as carbonic acid from the lungs of a man in health varies from 6 ozs. to 13½ ozs. daily, the difference being dependent on temperature, exercise, &c. Dr. Edward Smith says that it amounts to—

7.85 ozs. daily while the body is quiet;
9.11 ozs. do. with moderate exercise;
12.9 ozs. do. with considerable labour.

And he considers that a healthy man of average weight (150 lbs.) emits 8.57 ozs. of carbon from his lungs daily. This, added to the quantity discharged from the skin and bowels, is not less than 9.6 ozs. daily (= 4,200 grains) or just 28 grains per lb. of the man's weight. During light labour, he says it ranges from 9.6 ozs. to 10.5, and during hard work from 12.5 to 14 ozs.

The amount of nitrogen excreted as urea, &c., in the urine is also subject to great variation, according to the diet and exercise. Dr. Parkes found, in his experiments on two soldiers, that with an ordinary diet and no exercise it amounted to 2.03 grains per lb. weight of the body (= 304 grains per 150 lbs.); and that with a non-nitrogenous diet and no exercise it was 0.95 grains per lb. weight (= 142 grains per 150 lbs.); and with the same diet and active exercise it was 2.42 grains per lb. weight (= 364 grains per 150 lbs.)

Professors Pick and Wislicenus observed that the nitrogen secreted during an ordinary diet and no exercise was at the rate of 1.53 grains per lb. weight (= 203 grains per 150 lbs.); and that it fell to a little less than 1 grain per lb. weight with a non-nitrogenous diet during the labour of ascending the Faulhorn.

The researches of the Rev. Dr. Haughton, of Dublin, have led him to conclude that an average-size man, performing routine work, secretes 187 grains of nitrogen as urea daily (= 1.25 grains per lb. weight); and Dr. Edward Smith has estimated it at from 0.93 to 1.4 grains per lb. weight—a fair average being 1.15 (= 173 grains per 150 lbs.)

The more extensive inquiries of Playfair, Ranke, Beigel, Moos, Vogel, and others, give a daily average of 171 grains of nitrogen as urea for a healthy man at rest, and 252 grains for ordinary labour.

It may therefore be safely concluded that with an ordinary diet an average-size man excretes daily as urea 175 grains of nitrogen; and during labour of a moderate description it amounts to about 250 grains. Adding to these the proportions of nitrogen excreted in other forms in the urine, and the quantities passed from the bowels, the total amounts are probably about 190 grains while at rest, and 300 grains when at routine work; the difference, perhaps, being more dependent on the food than on the metamorphosed tissues of the body.

It thus appears that the proportions of carbon and nitrogen excreted correspond very closely with those contained in the diets which experience has proved to be necessary for man's sustenance; for when the results are put into a tabular form they stand thus:—

DAILY REQUIREMENTS OF THE BODY.

	Nitrogenous Food. ozs.	Carbonaceous Food. ozs.	Carbon. grs.	Nitrogen. grs.
During idleness { By dietaries	2.67	16.83	= 3,856	187
as determined { By excretions	2.78	18.47	= 4,200	190
Average.....	2.72	17.65	= 4,028	188
Routine work { By dietaries	4.56	24.48	= 5,757	319
as determined { By excretions	4.39	19.80	= 4,813	300
Average.....	4.48	22.14	= 5,285	310

The first of these averages is represented by 2 lbs. 2 ozs. of bread, and the second by about 3½ lbs.

It appears also that the relation of the nitrogenous to the carbonaceous constituents of food should be about as 1 to 5½ or 6. These, in fact, are the proportions which Messrs. Lawes and Gilbert found to be best suited for fattening pigs. In milk the proportions are as 1 to 3·6 (the butter being calculated as starch); and no doubt these are the right proportions for the dietaries of children. Again it will be observed that the relation of nitrogen to carbon is nearly as 1 to 19; whereas in milk it is about as 1 to 11. Referring to table No. 4 (p. 80), it will be noticed that the proportions in bread are as 1 to 22, and in meat as 1 to 13, showing that the former requires the addition of plastic matter, and the latter of respiratory.

In preparing dietaries, however, it will be best to take a rather liberal view of the question, and, therefore, I shall adopt the conclusions of Dr. Edward Smith—that even in periods of idleness a man's daily food should contain not less than 4,300 grains of carbon, with 200 of nitrogen; and a woman's at least 3,900 grains of carbon, with 180 of nitrogen—these being the proportions which, in his opinion, are necessary to avert starvation diseases; and they are represented in the case of a man's diet by 19·25 ozs. of carbonaceous food, with 2·84 of nitrogenous. The diagram before you exhibits the amounts of different articles of diet capable of furnishing this quantity of nitrogenous matter, and it also shows the proportions of carbonaceous matter (calculated as starch) associated with it:—

AMOUNTS OF FOOD YIELDING 200 GRAINS OF NITROGEN OR 2·84 OZS. OF PLASTIC MATTER NECESSARY FOR A MAN'S DAILY DIET.

Description of Food.	OZS.	Carbon- aceous matter	Carbon
		in lt. ozs.	in lt. grs.
Skim-cheese.....	8·8	5·57	1,200
White fish.....	24·6	5·99	1,384
Skim-milk.....	94·1	8·96	2,059
Peas.....	12·6	9·33	2,141
New milk.....	91·4	9·40	2,160
Lean meat.....	18·3	11·36	2,629
Oatmeal.....	22·9	17·54	4,000
Wheat-flour.....	26·7	19·28	4,433
Baker's bread.....	35·6	19·28	4,433
Indian meal.....	26·0	19·83	4,554
Rye-meal.....	36·4	26·40	6,046
Barley-meal.....	45·7	34·02	7,800
Rice.....	45·7	34·02	7,800
Bacon.....	32·6	38·04	8,714

Carbon deficient.
Carbon in excess.

So that, whilst the first seven of these substances are deficient of carbonaceous matter (19·25 ozs. being required), the last seven contain it in excess. It is therefore not difficult to construct a dietary from the several tables which I have placed before you; but perhaps it would interest you to know exactly what are the actual dietaries in use among different classes of persons; and first I will direct your attention to what Dr. Edward Smith found to be the average weekly dietaries of the low-fed operatives of England, Wales, Scotland, and Ireland. (See table.)

WEEKLY DIETARIES OF LOW-FED OPERATIVES CALCULATED AS ADULTS (DR. E. SMITH). Containing

CLASS OF LABOURER.	Bread- Stuffs.	Pota- toes.	Sugars.	Fats.	Meat.	Milk.	Cheese.	Tea.	Carbon.	Nitro- gen.	Cost.
	OZS.	OZS.	OZS.	OZS.	OZS.	OZS.	OZS.	OZS.	GRS.	GRS.	s. d.
Needle-women (London)....	124·0	40·0	7·3	4·5	16·3	7·0	0·5	1·3	22,900	950	2 7
Silk-weavers (Coventry)....	166·5	33·7	8·5	3·6	5·3	11·6	1·0	0·3	27,028	1,104	1 11½
Do. do. (London).....	158·4	43·8	8·8	5·5	11·9	4·3	0·3	0·6	48,288	1,165	2 8½
Do. do. (Macclesfield).....	138·8	26·6	6·3	3·4	3·2	41·9	0·9	0·3	27,346	1,177	1 8½
Kid gloves (Yeovil).....	140·0	34·0	4·3	7·1	18·3	18·3	10·0	0·9	28,623	1,213	2 9½
Cotton-spinners (Lancashire)	161·8	22·6	14·0	3·1	5·0	11·8	0·7	0·7	29,214	1,295	2 3
Hose-weavers (Derbyshire).....	190·4	64·0	11·0	3·9	11·9	25·0	2·2	0·4	33,537	1,316	2 6½
Shoemakers (Coventry).....	179·8	56·0	10·0	5·8	15·8	18·0	3·3	0·8	31,700	1,332	2 7½
Farm labourer (England)....	196·0	96·0	7·4	5·5	16·0	32·0	5·5	0·5	40,673	1,594	3 0
Do. do. (Wales).....	224·0	138·7	7·5	5·9	10·0	85·0	9·8	0·5	48,354	2,032	3 5½
Do. do. (Scotland).....	204·0	204·0	5·8	4·0	10·3	124·8	2·5	0·7	48,980	2,348	3 3½
Do. do. (Ireland).....	326·4	92·0	4·8	1·3	4·5	135·0	—	0·3	43,366	2,434	1 9½
Mean of all.....	184·2	78·1	8·0	4·5	10·7	42·9	3·1	0·6	34,167	1,500	2 7½
Average per day.....	26·3	11·1	1·4	0·6	1·5	6·1	0·4	0·1	4,881	214	0 4½

You will see from this table that the poor needlewomen of London are the worst fed of all the operatives in the three kingdoms, for they subsist on a weekly allowance of 102·52 ozs. of carbonaceous food, with 13·49 ozs. of nitrogenous (=14·65 ozs. carbonaceous, with 1·93 ozs. nitrogenous daily), while the farm labourers of Ireland are, as regards the real nutritive value of their food, the best fed of the lower operative classes. But it will also be noticed that the cost of the weekly dietary of the Irish labourers is only 19½d. per week, while that of the needlewoman is 2s. 7d.—the latter feeding chiefly on bread, bacon, and tea, which are expensive foods, while the former consumes potatoes, milk, and Indian meal—foods which yield more nutriment for their money-value than the more expensive foods of the English, Welsh, and Scotch labourers. And now we will contrast the dietaries of the poorer classes of operatives with those of better-fed persons, as soldiers, sailors, navigators, &c.; and for this purpose I shall avail myself of the accurate returns obtained and published by Dr. Lyon Playfair:

DAILY DIETARIES OF WELL-FED OPERATIVES (PLAYFAIR). Containing

CLASS OF LABOURER.	Flesh-former.	Fats.	Starch and Sugar.	Carbonaceous.	Nitrogenous.	Carbon.	Nitrogen.
	OZS.	OZS.	OZS.	OZS.	OZS.	GRS.	GRS.
Fully-fed tailors.....	4·61	1·37	18·47	21·64	4·61	5,126	325
Soldiers in peace.....	4·22	1·85	18·69	22·06	4·22	5,246	297
Royal Engineers (work).....	5·08	2·91	22·22	29·38	5·08	6,494	355
Soldiers in war.....	5·41	2·41	17·92	23·48	5·41	5,561	381
English sailor.....	5·00	2·57	14·39	20·40	5·00	4,834	252
French ditto.....	5·74	1·32	23·60	26·79	5·74	6,379	405
Hard-worked weavers.....	5·33	1·53	21·80	25·42	5·33	6,020	375
English navy (Crimea).....	5·73	3·27	13·21	21·06	5·73	5,014	404
English navy (railway).....	6·8	3·82	27·81	37·08	6·8	8,295	482
Blacksmiths.....	6·20	2·50	23·50	29·50	6·20	6,864	437
Prize-fighters, training.....	9·20	3·10	3·27	10·70	9·20	4,366	690
Mean of all.....	5·81	2·42	18·63	24·31	5·81	5,837	400
Do. of low-fed operatives.....	3·04	0·641	21·18	22·78	3·04	4,881	214

In all these cases the carbonaceous matters of the food are estimated as starch; and I may state that the soldier's dietary, when at peace, is calculated from the rations of the English, French, Prussian, and Austrian service; and when at war, it is derived from the actual dietaries of European and American soldiers during recent wars.

It would be interesting, if time permitted, to compare these dietaries with the dietaries of hospitals, prisons, workhouses, and lunatic asylums; for we should then perceive not merely how greatly they vary in their nutritive value, but also how little attention is paid to the principles which ought to guide our public authorities in the construction of public dietaries. In the prisons of England, Scotland, and Ireland, the several dietaries for short terms of imprisonment, as well as for longer periods, and for hard labor, vary respectively to so great an extent as to furnish an inducement for the commission of crime in certain districts rather than in others, because of the richness of the prison rations; and in all cases the dietaries of prisons are so greatly in excess of those of the union, that in times of distress they offer encouragement for misdemeanour, in or-

der that the prison may be reached in preference to the workhouse; in short, while the day's rations of an unfortunate inmate of a union contain only about 17 ozs. of dry nutritious matter, that of a destitute debtor contains 19·4 ozs., and that of a convict 22 ozs.; moreover, a prisoner confined for more than a month, without hard labour, in the gaols of England, Scotland, and Ireland, would have 18·8 ozs., 22·4, and 23·9 of dry nutriment respectively; the average rations for hard work containing about 21·7 ozs., 31·5, and 25·6 in the prisons of the three countries.

Dr. Edward Smith has drawn attention to the serious want of uniformity in the dietaries of the unions of his district, and has urged the workhouse authorities to improve them. He also submitted to the Privy Council tables of dietaries, which are well suited to meet the requirements of the system at the lowest money cost. Here are a few of them, which may, perhaps, prove useful to those who are engaged in the benevolent work of supplying food to the poor in times of distress; and you will perceive that at various sums, from about 2s. to 3s. a week per adult, very substantial rations may be provided.

DIETARIES TO FURNISH AS NEARLY AS POSSIBLE 30,100 GRAINS OF CARBON AND 1,400 GRAINS OF NITROGEN PER MAN WEEKLY—WOMEN TAKE ONE-TENTH LESS.

Cost.	1s. 1½d.	2s. 0½d.	2s. 3½d.	2s. 4½d.	2s. 6d.	2s. 7½d.	2s. 8½d.	2s. 10½d.	3s. 1½d.	3s. 3½d.
	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.	Ozs.
Bread.....	144	128	160	160	128	160	160	160	192	160
Flour for dumplings.....	—	—	—	—	—	—	—	16	16	8
Oatmeal.....	16	32	16	32	32	16	16	16	—	8
Peas.....	—	—	—	—	12	6	—	—	—	—
Rice.....	—	—	16	—	—	—	16	—	8	8
Sugar.....	—	4	4	—	4	4	4	4	8	8
Treacle.....	—	16	8	8	8	—	8	12	8	8
Butter.....	—	—	—	—	2	—	—	2	—	12
Dripping.....	—	—	4	—	—	4	4	—	4	—
Suet.....	—	—	—	—	—	—	—	4	4	2
Meat without bone.....	8	8	—	8	8	8	16	12	8	24
Herrings.....	—	—	—	—	4	—	—	—	—	—
Bacon.....	—	—	—	8	4	8	—	—	8	—
Skimmed milk.....	70	140	60	70	120	120	70	120	0	100
Buttermilk.....	60	—	80	—	—	—	60	—	60	—
Tea.....	—	—	—	—	—	0·5	—	—	0·5	0·5
Coffe and chicory.....	—	2	2	—	1	1	2	2	1	1
Nutritive values { Carbon..	28,031	29,748	33,552	34,935	32,998	33,248	36,499	36,402	41,519	36,301
{ Nitrogen..	1,409	1,291	1,511	1,548	1,859	1,609	1,674	1,638	1,768	1,620

The dietaries of women should be about 1-10th less than those of men in the case of in-door operatives, but they ought to be from 1-3rd to 1-4th less than the larger dietaries of men engaged in out-door labor.

As regards the dietaries of children, it may be stated generally that the chief part of their food should be milk. Up to the age of nine or ten months it should, if possible, be the milk of woman, which is richer in sugar than cow's milk, and much less rich in caseine; failing this, however, asses' milk is a good substitute, as it contains nearly the same amount of sugar and caseine as human milk. M.M. O. Henri and Chevalier have given these as the proportions of the several constituents in 100 parts of the milk of different animals:—

	Asses' milk.	Woman's milk.	Cow's milk.	Goat's milk.	Sheep's milk.
Caseine.....	1·81	1·51	4·48	4·02	4·50
Butter.....	0·11	3·55	3·13	3·32	4·20
Sugar of milk.....	6·08	6·50	4·77	5·28	5·00
Various salts.....	0·34	0·45	0·60	0·58	0·68
Total solids.....	8·34	12·02	12·98	13·20	14·38
Water.....	91·66	87·98	87·02	86·80	85·62
Total.....	100·00	100·00	100·00	100·00	100·00

Cow's milk, therefore, diluted with about one-third its bulk of water, and sweetened with sugar, may be given to children; and up to nine or ten months no other food should be administered, for infants have not the power of digesting farinaceous or fibrinous substances. A child may take from two to three pints of milk thus diluted daily. After ten months, and to about twenty months, farinaceous matters may be mixed in gradually increasing quantities with the milk; and they should be well cooked by first baking them, and then thoroughly dissolving them by boiling. After this age, and up to the third year, the quantity of well-cooked farinaceous matters may be still further increased, and given as puddings with a little egg. Bread and butter may also be eaten, and towards the end of the time the child will digest well-boiled potato, with a little gravy of meat. From the third to the fifth year a little meat may also be given, and at the end of the ninth year it may partake of the usual food of the family; but all along it should make use of a large proportion of milk, in the various forms of bread and milk, or milk puddings with eggs. About the tenth year a child will require about half as much food as a woman; and at the fourteenth year it will eat quite as much as a woman; in fact, the proportion of food required by

the child is much greater per pound weight of the body than that of adults, because it has to form its tissues and build up its several structures. Dr. Edward Smith calculates that the proportions of carbon and nitrogen in the daily food at different ages should be about as follows:—

DAILY PROPORTIONS OF CARBON AND NITROGEN IN THE FOOD AT DIFFERENT AGES, PER POUND WEIGHT OF THE BODY.

	Carbon. grs.	Nitrogen. grs.
In infancy.....	69	6.78
At ten years of age.....	48	2.81
At sixteen do. do.....	30	2.16
At adult life.....	23	1.04
In middle age.....	25	1.13

So that for its weight the infant requires three times as much carbonaceous food and six times as much nitrogenous as an adult.

(To be continued.)

ON STELLAR SPECTROMETRY.*

BY PADRE SECCHI.

FRAUNHOFER was the first who analysed with the prism the light of some stars, and discovered in them lines analogous to those which he had discovered in the sun. Donati, an Italian astronomer, now at Florence, resumed these researches and extended their field; several astronomers followed, amongst whom the celebrated Mr. Huggins, to whom we owe a description of the spectra of a great number of stars, and the application of the principle of determining the substances contained in a star from the black lines of absorption, which we see in its spectrum, as was proposed by Kirchhoff. Mr. Huggins also made the wonderful discovery of the gaseous state of the nebulae.

The field opened by these discoveries was immense, and I tried to glean some ears in it. In the first epoch of these studies the principal stars only were examined, the imperfection of the instruments not allowing the examination of all the heavenly host. An optical combination which I had the good fortune to discover enabled me to extend the researches to the whole of the visible stars, and even to several ones only telescopic, which conceal perhaps the greatest mysteries of this kind.

This optical combination consists in a single prism of that kind which is used for direct vision combined with a cylindrical lens. This combination allows us to employ the full light of the star not diminished by absorption, as in common spectroscopes, due to the slit and to the several surfaces through which the light must pass. The image of the star in this system is found in the focus as a luminous line of white colour if there is no prism, and with the prism the image is decomposed into a series of luminous lines arranged according to their refrangibility, the interruptions due to the discontinuity of light appearing as black lines.

In these images the relative position of the lines can be measured with a common screw micrometer, and their absolute position can be obtained by comparison with fundamental stars, whose lines, on account of their intensity, can be fixed in an absolute manner relatively to chemical substances by a common slit spectroscope. This comparison and measurement is rendered more easy by an improvement introduced in the instruments, by

means of which I can see the direct image of the star together with the spectrum. The super-position of this image on a spectral line in a part of the field of the telescope marked by a wire, is susceptible of great nicety in measurement, and supplies very sure results. This is, in a few words, the apparatus employed in my researches, to which this last year I have made a considerable improvement by employing an eye-piece made with cylindrical lenses only. With these such a strength of light is obtained that I have been able to observe the spectrum of the stars of seventh and eighth magnitudes, of course quite invisible to the naked eye.

Let us come now to the results. For this purpose many hundred stars were passed in review, of every magnitude to the sixth. A catalogue of the chief of them has been made and partly published in the said memoirs. The work of the last year, yet unpublished, has been especially the examination of the red stars of smaller magnitude, of which a particular research was instituted, but which was superseded after the reception of the catalogue of Professor Schjellerup; all the objects contained in this catalogue (printed also in Chambers's beautiful treatise on Astronomy) have been examined to the eighth magnitude, beyond which limit my instrument cannot give a good spectrum.

The principal results and conclusions to which I have arrived are these:—

1st. All the stars in relation to their spectrum can be divided into four groups, for which the type of spectrum is quite different. The first type is represented by the stars Sirius, by Vega, or a Lyrae, and by all the white stars, as a Aquile, Regulus, Castor, the large stars in the Great Bear, a excepted, &c. The spectrum of all these stars consists of an almost uniform prismatic series of colours, interrupted only by four very strong black lines as they are given in the figure; of these black lines the one in the red is coincident with the solar line c of Fraunhofer, the other in the blue coincides with the line r, the other two are also in the sun, but they have no prominent place. These lines, however, belong all to hydrogen gas, and the coincidence of these black lines with those of the said gas has been, by careful experiments, made already by Mr. Huggins, and begun also lately by myself. In a Lyrae the coincidence is found to be perfectly accurate. Mr. Huggins, however, finds a little difference in Sirius, for which we may account in another way, as I will expose presently.

This first type of stars is very numerous, and embraces almost one-half of the visible stars of the heavens. We observe, however, some difference in individuals, so that in some stars the lines are longer, and in others narrower, which may be due to the thickness of the stratum which has been traversed by the luminous rays. The more vivid stars have other very fine lines occasionally visible; but which are not characteristic of the type-form. In this type the red colour is very faint in proportion to the blue, violet, and green, so that the colour of the star is tending to the blue hue, and occasionally to the green. Of this last kind is the group of the large constellation of Orion and its neighbourhood.

The second type is that of the yellow stars, as Capella, Pollux, Arcturus, Aldebaran, a Ursæ Majoris, &c. These stars have a spectrum exactly like that of our sun—that is, distinguished by very fine and numerous lines; these appear occasionally as a uniform spectrum when the state of the atmosphere is not good, but in general the lines may be distinguished very easily. A fuller description is useless, since the spectrum of the sun is very well known. The only thing which de-

* British Association, Norwich Meeting, Section A.

serves particular attention is that, in this class, occasionally the magnesium lines are very strong, so that it produces very strong bands, and the iron lines in the green are in some very powerful.

These stars can be distinguished even without the prism by the difference of colour and richness of yellow, which contrasts so much with the first type. Stars of the second type are very numerous, and embrace almost the other half of the stars.

The third and very remarkable type is that of orange or reddish stars. These have as a prototype the stars α Herculis, α Orionis, Antares, θ Ceti, β Pegasi, &c. The spectrum of these stars shows a row of columns at least eight in number, which are formed by strong luminous bands alternating with darker ones, so arranged by their shadow as to represent a series of round pillars, exactly as architects are accustomed to draw a colonnade. α Herculis is exceedingly remarkable in this regard; the other stars are more or less deeply divided into pillars, but it is quite impossible to describe the beauty of the appearance which is visible in a telescope on a fine night. All the pillars are generally resolved into smaller and finer lines, very sharp and brilliant, more or less resolvable in different stars. I have carefully drawn, after actual measurements, the appearance of α Orionis and α Herculis, and in the printed memoir Antares and Aldebaran. In these stars some of the divisions of the pillars correspond to some capital lines of Fraunhofer as D and b , but others, as c and f , although falling very near, do not coincide. The presence of hydrogen is, however, sure; the lines c and f having been found in the principal of them. The divisions of the pillars after many measurements have been found to agree perfectly in all these stars, so that this type is perfectly constant and characterised. In my catalogue twenty-five of these most interesting objects are registered, and I do not imagine that I have exhausted this number.

A very interesting feature connects this type with the preceding one.

I must remark, first, that we ought to distinguish between lines and bands of shadow. The lines are narrow, sharp, and neat, the bands are shaded, although, perhaps, each band may be composed of very small lines; the aspect for our instruments (as we use them now) is that of a more or less continuous shade. This shade is analogous to that which is produced on the sun's spectrum by the vapours of our atmosphere when it is near the horizon.

Now it is a very remarkable fact that the actual type in the preceding seem to differ from one another not in the metallic lines, but only in the nebulous bands. So, for instance, the spectrum of Arcturus and Aldebaran present the same metallic lines as α Orionis, but this has bands in addition. The feature, however, is so peculiar in its whole that a different type must be constituted. It is to be remarked, also, that all the pillars have their luminous side towards the red, while the shadowed side is towards the violet. This difference is only substantial, as we shall see presently.

The fourth type is not less remarkable. This is the result of a day's research on the telescopic stars of red colour. Some of these are very small, and none of them exceed the sixth magnitude. This is the reason why, in my first memoir, I limited the spectra to three types only, being only engaged in larger stars. The spectrum of this type consists only of three large bands of light, which alternate with the dark spaces so distributed as to have the most luminous side towards the violet. A

very fine prototype of this is seen in the small star of the Great Bear, placed $\alpha = 13^\circ 38' 5''$; $\delta = 46^\circ 15'$. But occasionally there are in the yellow and red numerous interruptions, which divide the large luminous spaces into smaller ones, as in $\alpha 22^\circ 52' 5'' \delta = -25^\circ 55'$ and $\alpha = 6^\circ 26' 9'' = 38^\circ 33'$. A great part of the red stars of the catalogue of Lalande, and of that of M. Schjellerup belong to this or to preceding type. Of this last class I have found seventeen very remarkable objects. The simple colour also here may be a guide in the research, since some of these are like drops of blood in the field of the telescope. It is to be noticed that the line of the magnesium b falls exactly almost at the end of the second luminous band in the green, but the full aspect of the spectrum does not justify the presence of such metal, but rather of a gas like carbon which has luminous bands corresponding almost to the dark of the stars, but not exactly.

I do not intend, however, to fix the nature of the substances, since I have not yet taken sufficient comparative measures of them. But it seems to me that we are authorized in supposing these stars to be in a different condition to others; perhaps partly in the gaseous state, or at least surrounded by a very large atmosphere, different certainly from that of the others.

The most striking object for its singularity which I have met in this examination of the heavens, and which is quite unique, with the exception of a very faint companion, is γ Cassiopeiae. This star showed to me for the first the lines of the hydrogen in a luminous state, exactly opposite to the dark one of all the others, and is quite the reverse of all those of the first type. The star β Lyrae has the same feature, but in a very faint degree.

We have, therefore, without doubt, in the heavens a grand fact, which is the fundamental distinction of the stars in a small number of types, which opens the field to very many cosmological important speculations.

Secondly, another grand fact, which was brought out from those researches was, that the stars of the same type are crowded occasionally in the same space of the heavens, so the white stars are thickly gathered in the Leo, in the Ursa Major, in Lyra, Pleiades, &c., while the yellow ones are very frequent in Cetus, in Eridanus, Hydra, &c. The region of Orion is very remarkable for having all through, and in the neighbourhood, green stars of the first type, but with very narrow lines and with scarcely any red colour. It seems that this particular kind of star is seen through the great mass which constitutes the great nebulae of Orion, whose spectrum may contrast with the primitive spectrum of the stars. Sirius is perhaps too near us to be affected by this influence. The distribution of stars seems to indicate in space a particular distribution of matter or of temperature in the different regions.

Thirdly, a very remarkable conclusion arrived at is that all the spectra of the third and fourth type belong to variable stars. The representative of these is the wonderful (Mira) Ceti. This has been carefully examined and found that, even when it is only of the seventh magnitude, it has the same spectrum as the typical, but only reduced to its few bright lines; α Orion is in the same condition, α Tauri or Aldebaran, and Antares, this year appeared to be smaller and of a more red hue than in the past year, and in the first appeared traces of columns which were not seen the year before: so that it is evident that the change of these stars depends on a periodical change which happens in their atmosphere. It is not so, however, with Algol, which has the very

same spectrum of the first class or type in every stage of greatness; which induces me to believe that there the variation is produced by the passage of an opaque body passing between us and the central star, giving thus an example of eclipse of a fixed star by his own obscure planet.

Finally, a very delicate question I propose to myself to be resolved by spectral analysis; this consists in ascertaining whether the star has a proper motion from the displacement of the lines, which ought to take place in the spectrum by the combined motion of the star and the propagation of light. From this new kind of aberration it would be easy to ascertain if a star has a motion whose velocity should be five times that of our earth around the sun. The star α of Lyrae examined in this manner has not given any such displacement, so that it appears not to have such a motion. In some other stars I have found that there is a little displacement, as in ϵ Ursæ Majoris, but this seems especially due to the different breadth of the hydrogen line in the star and in the compared spectrum. I have employed for this study the comparison of the direct image of the stars with its own spectrum, but I have found no such quantity of displacement. But my first researches of this kind started from the supposition that in Sirius there was a perfect coincidence of the lines of the hydrogen with those of the stars; now I am told that your celebrated countryman, Mr. Huggins, has found a little difference for Sirius. As his opportunity of comparisons is greater than mine, I leave to him the solution of this question, satisfied that the first proposal of this method for determining proper motion of the stars which I made since the year 1863 has been well received by such a competent judge.

I will conclude with a few words on nebulae, and especially on that of Orion. I have the honour to present a drawing of it made with the best care, which is intended to show how far we may see with a single nine and a half inch object glass, leaving to your gigantic instruments to penetrate more deeply into these wonderful objects. I shall say only that in the other side of the galaxy I have examined several nebulae and found them to have the same spectrum as θ Orionis, only a difficulty arose in my mind about this subject, which is as follows: How can it be that while the hydrogen gas has so fine and rich a spectrum, we do not see in the nebula anything except the single line f . I undertook therefore a kind of photometrical discussion of the intensity of luminosity of the different lines which constitute the spectrum of this substance, and the result was that in diminishing by an absorbing screen and single reflections the light, we could reduce the spectrum to a single line f , as we see in the nebulae. Even hydrogen burning at common temperature has not given any line beyond this after reflection.

The difficulty is, therefore, completely removed, being only a question of intensity of light.

Here you see that the matter is not exhausted: we want yet to make a more thorough review of our discovery to settle many points in question. It is to chemical men to resolve some of these difficulties; the astronomer can only here walk after the lamp of chemistry. We had already a great satisfaction in seeing just lately that brilliancy of a comet was due to the rays of carbon. Ere long we shall more accurately know what nourishes the light and heat in so many bodies which are scattered in the profundity of space.

ON A NEW REAGENT FOR ESTIMATING THE AMOUNT OF CARBONIC ACID IN BICARBONATES CONTAINED IN NATURAL WATERS.

BY M. CH. LORY.

IN the course of my late experiments upon the natural waters of Isere, I was greatly interested in the ingenious method pointed out by M. Barthélemy (*Annales de Chimie et de Physique*, Janvier, 1868), of estimating the amount of carbonic acid in the bicarbonates contained in natural waters, by means of a standard solution of mercurial nitrate, containing an excess of nitric acid. The use of this reagent is easy, and gives, in many cases, very satisfactory results; but owing to the insolubility of the protochloride of mercury, this method loses its exactness when the waters contain evident traces of chlorides, and becomes inapplicable as soon as the proportion of chlorides increases to several centigrammes per litre. It also appears to be unadapted to the treatment of waters highly charged with sulphates, or containing organic matter, &c. My endeavour has been, while preserving the principle of the method, to replace the mercurial salt by a reagent capable of more general employment, and not subject to exclusion in similar cases. After several experiments I have discovered such a reagent in solution of phosphate of copper dissolved in a slight excess of chlorhydric acid, obtained by precipitating the bichloride of copper with common phosphate of soda, washing the precipitate, suspending it in water, and dissolving it in chlorhydric acid, added drop by drop. If this reagent be poured into a water containing alkalies or alkaline earths in the state of carbonates or bicarbonates, these bases will saturate the chlorhydric acid in the first drops which are thrown in, and the phosphate of copper will form a bluish cloud in the water; as more is poured in this turbidity dissolves in the excess of acid, and the exact moment when the water again becomes quite limpid must then be seized. By stopping at this point, the quantity of reagent employed will evidently be proportional to the total equivalent of the bases, and consequently to the quantity of carbonic acid combined with them as bicarbonate. This I have ascertained with regard to admixtures of waters containing different proportions of bicarbonates, either with each other or with distilled water; I have also proved that the standard given by the reagent does not change when the water is previously saturated with free carbonic acid gas.

To obtain the standard of the reagent I dissolved in 1 litre of distilled water 0.265 grammes = 1-200th of an equivalent of carbonate of soda, dry and pure, passing through it a current of carbonic acid, to produce a bicarbonate. The copper reagent which I employed was such as to require exactly 4.4 c.c. to create in 1 decilitre of water the reaction described. For the treatment of every other water, it will be found sufficient to multiply by $\frac{1}{4} = .5$, the number of cubic centimetres employed for 1 decilitre, to obtain the number of centigrammes combined per litre; the employment of a measure graduated in 5ths of cubic centimetres will give precisely similar results.

This reagent is unchangeable, and easily prepared, and is effectual, no matter what quantity of chlorides, sulphates, &c., be contained in the water; it may even be employed for the alkalimetric estimation of very dilute liquids; but it should be remarked that the reaction is much more exact with bicarbonates than when the bases exist as neutral carbonates of free alkalies. By

combining this quick and simple test with the test by the standard solution of soap, both in the natural water and also in the same water after boiling, the most important elements for the appreciation of its ordinary and hygienic qualities will be obtained.

The chlorides may be quickly estimated by adding to 0.1 litre of water a small quantity of chromate of potash, and then a very dilute standard solution of nitrate of silver containing 4-100ths of an equivalent per litre, until the yellowish straw colour of the liquid, at first rendered merely opaline by the formation of chloride of silver, begins to turn reddish from the admixture of the chromate of silver. With regard to sulphates their presence is discovered qualitatively by chloride of barium; but in order to estimate quantitatively by means of this reagent, the amount of sulphuric acid, it is necessary to employ the method pointed out by Mohr, which, although longer and indirect, will, however, give very precise results.

ON THE CHEMISTRY OF SOME CARBONIFEROUS AND OLD RED SANDSTONES.*

BY J. WALLACE YOUNG.

SANDSTONE is generally understood to consist of quartz grains—popularly called sand—bound or cemented together into a more or less compact mass, the cementing material consisting of such substances as the carbonates of iron, lime or magnesia, clay, and silica. It is not my intention at present to enter into the origin of sand, but rather to draw attention to the nature of the cementing and colouring materials of some sandstones of the carboniferous and old red formations, and more particularly those found in the neighbourhood of Glasgow.

On the Nature of the Cementing Material.—Sandstone may have been cemented together by the decomposition or re-arrangement of some of the constituents previously in the sand, or by the addition of such substances as carbonate of lime and oxide of iron, deposited from springs. Professor Church, in some interesting notes on the recent formation of some rocks, observes, "that at Bude Haven, Cornwall, and elsewhere, coarse grained sand is in many cases being cemented together by the action of the water of land springs containing carbonic acid, which, percolating through the sand and dissolving the fragments of shells contained therein, the carbonate of lime is subsequently at some other point slowly deposited as the carbonic acid escapes, thus forming a cementing material for the sand."

In cases where the quantity of carbonate of lime is large, it may probably have been derived from adjacent limestone rocks.

When we place a few fragments of a sandstone in hydrochloric acid and apply heat, we are enabled at once to determine whether the cementing material is acted on to any considerable extent. If of a siliceous or felspathic nature, it will be scarcely, if at all, affected; if, on the other hand, it consists of such substances as carbonate of lime, or peroxide of iron, it will be removed by the action of the acid, and the sandstone will be more or less disintegrated. After treating the sandstone with acid, it is necessary to make a careful examination of the residual sand. In the analyses which accompany this paper, I have, in general, indicated the nature of this sand in the different specimens

examined. In most cases it appeared to consist of quartz grains, sometimes smooth and round, at other times small and angular, usually accompanied by a finely divided substance, which, in fact, possessed all the properties and composition of clay. I have frequently found as much as 7 or 8 per cent of this clayey matter. Fragments of mica were almost invariably present, and always of the white variety; I have only twice observed any of the black variety, and this seems a little curious when we consider that it occurs so very frequently in those rocks from which the sand must have been derived. It has been suggested that as black mica seems to be more susceptible of change, it may either have been decomposed, or converted into the white variety.

Occasionally rounded fragments of felspathic or other analogous rocks were found accompanying the quartz. When we find quartz alone present, it is probable that the rocks from which those sandstones were derived, have undergone greater decomposition than those in which felspathic or other fragments are found. The former may have been solidified, decomposed, and re-solidified several times, until the only substances which point to the former presence of other matter, are the fine clay and fragments of mica. In the latter, on the contrary, we find some of the other rock fragments still entire, proving that they have not undergone the same extensive decomposition. I am here taking it for granted that the sand has been primarily derived from those crystalline rocks containing free silica.*

It is often rather a difficult matter to indicate the conditions under which certain sandstones have been formed. Take, for instance, the hard fine white sandstone which is so extensively quarried at Bishopbriggs. According to the analysis given elsewhere, it consists of very fine round grains of quartz, a little mica, and some fine white clay, the whole cemented together by 33.49 per cent of carbonates. Amongst these we find carbonate of iron to the extent of 6.62 per cent.; now, it is perfectly certain that atmospheric air (or oxygen) cannot have been present during its deposition, or else the iron would have been peroxidised and the carbonic acid separated. The same remark applies to all those cases in which carbonate of iron is present. Generally speaking, I find that those sandstones which contain carbonates are harder the greater the quantity present. This agrees with the observations of Bischof.

I shall now proceed to give a short account of a few of the sandstones examined.

CARBONIFEROUS SANDSTONES.

Braidbar Quarry, Cathcart.—Some parts of this sandstone are curiously streaked in all directions with peroxide of iron, presenting often a most beautiful appearance. It is moderately fine grained, and not very hard. No effervescence with HCl†. The peroxide of iron was determined in one portion, and amounted to 1.52 per cent. The residue consisted of rounded quartz grains, a few plates of mica, and a considerable quantity of fine clay; this last seemingly acted the part of

* M. Daubrée, by subjecting fragments of granite, &c., to rotation in a cylinder in presence of water, found, after a certain time, that the quartz was reduced to the state of fine sand, and the felspar to a very fine mud, the water at the same time becoming highly charged with alkaline silicate. It would thus appear that by the simple rubbing together of grain against grain, the felspar being reduced to a minute state of division, is decomposed by the water, alkaline silicates being removed in solution, and the silicates of alumina left as clayey matter. This appears to explain satisfactorily the reason we find felspar grains so seldom present, but almost always clayey matter accompanying the quartz.

† I have used the symbol HCl for hydrochloric acid for the sake of brevity.

* Transactions of the Geological Society of Glasgow.

cementing material. At a part of the same quarry wrought under ground, there is a marked difference in the nature of the cementing material; it consists of 13.24 per cent of carbonates, as follows:—

Carbonate of Lime.....	527	per cent.
" of Magnesia.....	304	"
" of Iron.....	493	"

residue, quartz grains, a little mica, and clayey matter.

Varieties from Newton Coal Pits, near Cambuslang.—

(a.) The curious brown bituminous sandstone, with the regular white streaks running through it, which has been described in the *Transactions of the Geological Society of Glasgow*,* is found here. It possesses a faint odour like paraffin oil, and benzol dissolves out most of the bitumen. It effervesces slightly with HCl. Residue, quartz grains, a little mica, and a considerable quantity of fine white clay.

The white streaks are in some pieces remarkably straight, and occur at regular distances; in other pieces, however, they become gradually closer and more confused, running into one another, become abrupt, and then cease, the sandstone being then of a uniform brown colour throughout. Large portions, evidently of the same sandstone, are white, with a single brown bituminous streak here and there. I cannot agree with the explanation of this phenomena given in the paper previously referred to. The bitumen appears to me to proceed rather from the simple decomposition of vegetable matter under certain peculiar circumstances, but I am quite unable to account satisfactorily for the remarkable regularity of the white lines.

(b.) A beautiful micaceous sandstone; splits readily into very thin layers, the surfaces of which are very thickly covered with plates of mica and purple-coloured spots of peroxide of iron. Effervesced with HCl, the acid removed some carbonate of lime, a little alumina, a large quantity of peroxide of iron, and slight traces of magnesia. Residue, white, contains quartz, mica, and fragments of some felspathic or other analogous rock, and a little clayey matter. Solution of carbonate of sodium extracted a very little silicic acid from the residue.

No. 1. This variety is white and friable; effervesced slightly with HCl, which extracted 3.44 per cent of substance, the composition of which is shown is No. 1 of the following table:—

	1	2	3	4	5
Carbonate of Lime.....	2.06	20.06	14.60	13.87	17.97
" Magnesia.....	traces	14.78	11.21	6.51	14.59
" Iron.....	1.38	—	5.51	6.07	.97
Peroxide of Iron.....	traces	4.4	—	—	2.25

No. 2 is the soluble portion of some large red lumps found in the foregoing sandstone; they are very hard, and easily separated from the white. Residue, colourless quartz grains, and a little clayey matter.

No. 3. Another variety; greyish-coloured, and rather hard. Residue, quartz grains, pretty large and transparent.

No. 4. Colour, white; fine-grained; hard. Residue, quartz grains, with a small quantity of clay.

No. 5. Colour, brownish-red, speckled with white; hard. Residue, quartz sand with a little mica.

These varieties are principally interesting on account of the large and varying quantities of the carbonates of iron and magnesia which accompany the carbonate of

lime. It may perhaps be necessary to state here, that the foregoing table, and other subsequent ones, display the composition of the substance removed from each sandstone by HCl, the residual sand forming the remainder of the 100 parts.

Varieties from Bishopbriggs Quarries.

	1	2	3	4
Carbonate of Lime.....	5.0	17.32	6.87	10.92
" of Magnesia.....	2.66	9.55	3.75	traces
" of Iron.....	2.38	6.62	2.79	.93
Peroxide of Iron.....	.76	.88	.67	.48

Nos. 1 and 3. From quarry near railway station. Colour, whitish; fine-grained; moderately hard. Residue, quartz grains with fragments of mica, and some fine white clay.

No. 2. From adjoining quarry; a very hard variety; colour, white; fine-grained. Residue, very fine rounded grains of quartz, with a few plates of mica, and a considerable proportion of fine white clay.

No. 4. From the side of a trap-dyke.

Nos. 1, 2, and 3, are extensively used as a building material.

From a Coal Pit near Bishopbriggs.—This sandstone contains layers of a brown impure iron ore running through it; contains 16.07 per cent of protoxide of iron = 25.89 per cent of carbonate, also some carbonate of lime and magnesia, peroxide of iron, and a trace of alumina, which were not estimated. Residue, quartz grains, with fragments of mica. It would appear that a deposition of iron ore was occurring simultaneously with the formation of this sandstone. Another specimen of a very similar nature and appearance, from near Edinburgh, contained 12.30 per cent of protoxide of iron = 19.81 per cent of carbonate.

Eastfield, near Cambuslang.—The portion examined was not very hard. Colour, greyish, owing to the presence of a little carbonaceous matter, effervesced with HCl, which removed 7.53 per cent of substance as follows:—

Carbonate of Lime.....	4.80	per cent.
" of Magnesia.....	1.93	"
" of Iron.....	.80	"

Traces of manganese and peroxide of iron. A large round mass found in this sandstone, and which it appears the quarrymen call "bastard whin," was simply a very hard cream-coloured piece of sandstone. Effervesced with HCl, which dissolved 29.26 per cent of carbonates as follows:—

Carbonate of Lime.....	15.42	per cent.
" of Magnesia.....	9.84	"
" of Iron.....	4.00	"

The difference in hardness is owing to the increased amount of carbonates. These large round masses are very frequently found in quarries. The sand of which they are composed appears to be similar to that of the surrounding rock, the only difference, as far as I could see, being in the amount of cementing material.

Abbey Craig, near Stirling.—Colour, white; coarse-grained, and not very hard. HCl extracted 4.33 per cent of substance—

Carbonate of Lime.....	2.00	per cent.
" of Magnesia.....	.48	"
" of Iron.....	1.85	"

The residue contained a considerable quantity of fine white clay.

The Wallace Monument is, I understand, partly built

* (Vol. xiv., p. 35.) On some peculiar varieties of Old Red and Carboniferous Sandstones from the neighbourhood of Glasgow. By John Young.

of this stone. As it is in many parts so extremely coarse-grained, and owing to the nature of the cementing material, I cannot believe that it will possess the durability requisite for a memorial of this kind.

Craigleith, near Edinburgh.—Fine-grained, hard; colour, white. Gives a very slight, but decided effervescence with HCl. The acid solution contained small quantities of peroxide of iron and lime. Residue, quartz grains, with a little mica. The cementing material appears to be felspathic matter. In other sandstone from Mugdock, Locherdinan, near Strathblane, Carluke, &c., the cementing matter was also of a similar nature.

The copper ore, which was formerly wrought at Gourrock, occurs disseminated in a conglomerate sandstone. The pebbles are principally quartz, and the cement appears to be of clayey or felspathic nature.

Slamannan.—Colour, greyish-white, very hard; contains the remains of shells (*Anthracosia*). HCl removes 60·20 per cent.

Carbonate of Lime ..	51·06 per cent.
“ of Magnesia	3·78 “
“ of Iron	4·39 “
Peroxide of Iron and Alumina.	·97 “

Residue, fine quartz sand, with some clayey matter, and plates of mica.

The red sandstone which overlies the carboniferous strata in the West of Scotland effervesces freely with HCl. The acid solution contains large quantities of lime and peroxide of iron, and a little magnesia. Residue, not quite colourless, and not wholly quartz sand; a considerable quantity of white mica is present, and a few fragments of the black variety.

Giffnock Quarry, near Pollokshaws.—Colour, whitish; fine-grained; moderately hard. HCl removed 10·02 per cent of the substance—

Carbonate of Lime	4·78 per cent.
“ of Magnesia	2·49 “
“ of Iron	2·36 “
Peroxide of Iron	·39 “

Residue, very fine quartz sand, with some mica, and a little clayey matter.

A rounded mass of the so-called “bastard whin,” nearly 7 feet in circumference, was found lying in this quarry. It was extremely hard, and it was with difficulty that fragments sufficient for analysis could be obtained.

Colour, white; fine-grained. HCl removed 39·83 per cent of carbonates—

Carbonate of Lime	19·53 per cent.
“ of Magnesia	10·62 “
“ of Iron	9·65 “

Residue, similar to the foregoing.

A part of the surface of this lump was very much decomposed, being of a deep brown colour and quite soft, from the decomposition of the carbonate of iron.

OLD RED SANDSTONES.

Falls of Clyde, Lanark.—Colour, purplish red; coarse-grained; effervesced briskly with HCl. The acid solution contained a large quantity of peroxide of iron and lime, some protoxide of iron and alumina, and a trace of magnesia. Residue, fragments of different coloured quartz, felspar, a little mica, and a few dark-greenish grains.

From the Tweed at Dryburgh.—Colour, deep red; fine-grained; considerable effervescence with HCl. The solution contained a large quantity of lime and

peroxide of iron, with considerable traces of magnesia and protoxide of iron. Residue, not quite colourless, and not wholly quartz, small quantities of clay and mica being present.

Finnich Glen.—Colour, reddish; brisk effervescence with HCl. Some portions of this sandstone are much harder than others; the following table shows the composition of the part removed by the acid from the two varieties:—

	Harder portion.	Softer portion.
Peroxide of Iron	2·10 per cent.	1·27 per cent.
Carbonate of Lime	16·60 “	10·95 “

Residue, not quite colourless, principally quartz, with a little felspar. No mica observed in portion examined.

Port Glasgow.—Colour, greyish-white; rather hard. HCl removes 16·40 per cent of substance—

Peroxide of Iron and Alumina	·30 per cent.
Carbonate of Lime	16·10 “

Considerable tracts of magnesia. Residue, chiefly quartz, not quite colourless, a little mica and fine clay. This sandstone occurs in regular beds, alternating with a reddish marl or limestone.

Loch Thom, above Greenock, Ballagan Series.—Colour, dirty white; moderately coarse-grained and hard. The cementing material is in this case carbonate of lime, with considerable traces of protoxide of iron and magnesia.

From Arbroath.—Colour, pale reddish; coarse-grained. HCl removed 23·18 per cent of substance—

Peroxide of Iron and Alumina	5·22 per cent.
Carbonate of Lime	17·06 “

Traces of protoxide of iron and magnesia. Residue, not quite colourless, fragments of quartz and felspar. A considerable quantity of white mica was present, accompanied with a few fragments of the black variety.

Many other varieties of sandstone from Largs, Dumbartonshire, and other districts, invariably contained carbonate of lime in conjunction with a ferruginous clayey matter.

Conglomerate, Cullander, Perthshire.—Hard; appearance, red. Consists of various pebbles, such as porphyry, quartz, greenstone, mica slate; a slight effervescence was perceived with HCl. The cementing material is of a felspathic nature, produced evidently by the decomposition of some of the ingredients.

Two varieties of red sandstone (Permian?) from Annan, Dumfriesshire, contained no carbonates, the cementing material being a ferruginous clay.

From Gourrock.—Colour, whitish; rather hard. HCl removed 26·87 per cent of substance—

Alumina and Peroxide of Iron	·32 per cent.
Carbonate of Lime	26·55 “

Residue, quartz sand, with some felspar and a few particles of mica.

From Bute.—Colour, red. Effervesced with HCl, which removed the following:—

Peroxide of Iron	2·07 per cent.
Carbonate of Lime	6·07 “

Traces of magnesia and alumina. Residue, colourless, chiefly quartz grains, with some fine white clay.

From Dumbartonshire.—Coarse-grained; colour, red; contained mica. HCl removed the following:—

Peroxide of Iron	2·70 per cent.
Carbonate of Lime	9·60 “

From Lassic Mill, Forfarshire.—Colour, greyish; fine grained. Effervesced with HCl. The solution contained considerable quantities of protoxide of iron and lime, with some alumina and peroxide of iron. The residue consisted of insoluble silicates, quartz, and fragments of mica. A boiling solution of carbonate of sodium extracted a considerable amount of soluble silicic acid from the residue.

Caithness Flagstone.—Used as a paving material; colour, greyish; irregular bands of quartzose matter running throughout. Effervesced with HCl. The acid solution contained lime, magnesia, alumina, and protoxide of iron. The residue consisted of insoluble silicates, quartz, and fragments of mica. Solution of carbonate of sodium extracted a considerable portion of soluble silicic acid.

The two foregoing sandstones differ entirely from all those previously examined; they appear to consist of—

Carbonates.	Insoluble Silicates.
Soluble Silicates.	Quartz, and fragments of Mica.

In general appearance and character they approach rather to a clayslate than to sandstone.

ON THE COLOURING MATTER OF SANDSTONES.

Iron, in one shape or another, from its wide diffusion, is unquestionably one of the most common colouring matters of sandstone. It produces the various shades of brown, red, purplish red, crimson red, &c., so frequently observed. These shades of colour appear to be due to peroxide of iron alone, and their difference of tint may, perhaps, be owing partly to varied degrees of hydration, according to the circumstances under which they were produced. It is well known that artificially prepared peroxide of iron differs much in shade, according to the source whence it was obtained.

The red colour of sandstones seems not to depend so much on the amount of peroxide of iron present as upon the way in which it occurs. Upon examination, each little quartz grain of which the sandstone is composed, will be found to have a slight coating of the red oxide, and which in most cases can be readily removed by HCl. A small portion of peroxide of iron thus appears to be able to colour a considerable quantity of sand.

A sandstone which may appear almost quite white to the eye often contains more peroxide of iron than a red one; but upon further examination, it will generally be found that it proceeds from minute specks or spots, disseminated throughout the mass. This, of course, applies exclusively to peroxide of iron, as large quantities of protoxide of iron may exist without colouring the sandstone.

In many red sandstones we find white blotches and spots, round rings, &c. These appear to be due to the removal of some of the iron oxide. The following analyses may serve to illustrate this:—

	1		2		3	
	A	B	A	B	A	B
	Per	Per	Per	Per	Per	Per
	Cent.	Cent.	Cent.	Cent.	Cent.	Cent.
Peroxide of Iron.....	14	76	65	220	37	175
Carbonate of Lime....	—	—	13.30	12.72	2.22	1.15
Carbonate of Magnesia,	{	—	—	trace	—	—
Sand, &c.....						

No. 1. *From Port Glasgow.*—Colour, deep red, with

large irregular white blotches; not very hard. No effervescence with HCl. Residue, quartz grains with a little mica. Peroxide of iron in "A" the white, and "B" the red portion.

No. 2. *From Dumbartonshire.*—Colour, red, with large white blotches; moderately hard.

"A." Substance removed from the white part by HCl.

"B." " " " " red " "

No. 3. *From Largs.*—Fine grained; moderately hard.

"A." Substance removed from the white part by HCl.

"B." " " " " red " "

Residue, quartz, with some felspar, and a few fragments of mica.

The only explanation which has been given of these phenomena, as far as I am aware, is the presence of some organism in the sand, the decomposition of which has reduced the peroxide to the protoxide of iron, which would be subsequently removed as carbonate, by water containing carbonic acid percolating the mass.* The carbonate of lime would be, of course, added subsequently.

Silicates of iron frequently colour sandstones green, but I have not met with any of these. The only green coloured sandstone which has come under my notice is a fragment I picked up on the sea-shore at Portobello, near Edinburgh, the colour being due to a carbonate of copper. The following is the centesimal composition:—

Alumina and Peroxide of Iron..	730
Carbonate of Lime.....	650
Carbonate of Copper	340 (CuO. 2.5 per cent.)
Loss on drying at 100° C.....	135
Quartz, Sand, &c.....	88.15

99.70

Sandstones of different shades of brown and black are often found in our coal measures; the former generally proceeding from bituminous, and the latter from carbonaceous matter.

The peculiar striped variety of sandstone referred to above must be classed with these, but the exact method by which the alternate layers were produced must still be matter of conjecture.

The principal results of my experiments lead to the following conclusions:—

1st. That in the greater number of sandstones examined, the cementing material consisted of carbonates.

2nd. That very considerable quantities of the carbonates of iron and magnesia frequently accompanied the carbonate of lime, although no definite ratio seems to exist between them. That the carbonates were chemically combined in some way is, the author thinks, probable, as weak acids caused only a very feeble effervescence in those sandstones where any considerable quantity of the carbonates of iron and magnesia was present, differing entirely from the very brisk action of a similarly diluted acid where carbonate of lime alone existed.

3rd. That these sandstones, generally speaking, were harder the greater the proportion of carbonates.

4th. Mica was found to be present in nearly all those examined, and, with two exceptions, was always of the white variety.

5th. Soluble silicates were only found in three sandstones in any quantity; all three belonged to the Devonian system.

* Mr. James Bannan, who has so diligently investigated the surface geology of Glasgow, informs me that he has frequently observed sand in contact with decaying roots or twigs to be partially bleached.

6 h. Insoluble silicates which, for want of a better name, I have in general called felspathic or clayey matter, appear to be almost always present in more or less quantity.

7th. The round masses so frequently encountered in quarries in our neighbourhood, and known as "Bastard whin," by whatever cause produced, appear to be simply parts in the sandstone rock which have become excessively hard from an increased proportion of carbonates, and are thus more or less easily separated from the surrounding rock.

8th. That the different red shades of colour observed in sandstones, more particularly in those belonging to the Devonian group, appeared to be due solely to peroxide of iron, and that the white rings and spots so frequently met with have resulted from the reduction and subsequent removal of the greater part of this iron.

ON THE COLOURED REACTIONS OF ANILINE, TOLUIDINE, AND PSEUDO-TOLUIDINE.

BY M. ROSENSTIEHL.

THE alkaloids used in the examination of these reactions were prepared with salts whose purity had been proved by the constancy—first, of the reactions, and secondly, of the solubilities, after fresh crystallisations. Since the first introduction of aniline into commerce, a large number of highly sensitive reactions have been made known, which were believed to be characteristic of this base; but the fact of the presence of pseudo-toluidine in this commercial product throws some doubt upon the worth of this means of analysis. By subjecting these reactions to a vigorous revision, I have discovered that there exists only one really characteristic of aniline—viz., that discovered by Runge; this has been accused of being very variable, but a slight modification will not only render it much more certain, but also greatly increase its sensibility. If a few drops of a solution of chloride of lime be added to aniline suspended in water the intense blue colour first developed will quickly change to brown. In the presence of homologous alkaloids, the blue colour becomes gradually less apparent, disappearing before the brown products yielded by the toluidine; if, however, a little ether be added, and the mixture carefully stirred, all the brown matter will be retained by that solvent, and the water will assume a pure blue colour. Should the discovery of traces of aniline in a mixture (toluidine, for instance) be desired by this process, about 1 gramme of the alkaloid must be dissolved in 10 cubic centimetres of ether, an equal volume of water must then be added, and into this mixture a solution of chloride of lime, 1.055 in density, is gradually dropped, carefully stirring after each addition. When only very small quantities of aniline are present the water gradually assumes a blue tint; and it is important to exhaust the action of the chloride of lime without introducing an excess of the reagent. According to experiments made in conjunction with M. Clemm, it appears that 5 cubic centimetres of chloride of lime, 1.055 in density, are requisite for 1 gramme of alkaloid. The quantity of aniline contained in a mixture may be ascertained up to a certain point by working comparatively with a standard. By this approximate method, I discovered the presence of 2 per cent of aniline in M. Coupier's toluidine. In the above experiment pseudo-toluidine may be substituted for aniline, in which case the water turns yellow, while the ether is simultaneously charged with a slightly coloured base, whose salts are of a fine violet red. If this etherised film be

decanted and stirred in slightly acidulated water the liquid will assume a tint comparable in beauty and intensity to that of a permanganate solution. This reaction is very sensitive, allows pseudo-toluidine to be discovered in the presence of the other two alkaloids, and would be still more clearly perceptible if the quantity of the former mingled with these latter were not so small. The reactions given by toluidine with chloride of lime are negative only.

Most of the other reactions proposed for aniline rests upon its transformation, by means of sundry oxidising agents, into Perkin's purple, which is well known to be transmutable by the aid of acids, into blue, green, and even yellow; these colours may be considered as corresponding with polyacid salts of mauveine. The blue colour being much the most intense, it is that which we should endeavour to induce, if the discovery of small quantities of colouring matter be desired; the above colour may be instantly obtained by means of dihydrated sulphuric acid, in which medium it is very stable, provided concentration of the acid remains unchanged.

All bodies which liberate chlorine or oxygen in the presence of sulphuric acid yields highly intense blue shades in connection with aniline and pseudo-toluidine; such are the chromates, oxygenated compounds of chlorine and manganese, binoxide of lead, chlorine, oxygen evolved at the positive pole of the pile, and an admixture of nitric and chlorhydric acids. Toluidine yields no colour with either of these reagents. Until now no means were known of discovering this base; but if the reagent be changed, and nitric acid employed as an oxidising body, the actions are exactly reversed. When working in the cold, aniline and pseudo-toluidine give no colour, while toluidine yields a pure intense blue. This reaction is very delicate, and requires exactly the conditions described; dissolve the toluidine in dihydrated sulphuric acid, let it cool, pour several cubic centimetres of this solution into a thoroughly dry tube, and add a drop of nitric acid; the colour is produced in a second, lasts about a minute, and then changes to violet and red. This reaction offers the double advantage of allowing the discovery of small quantities of nitrates in the presence of chlorides and chlorates, and also of recognising small quantities of toluidine in a mixture, as, for instance, in commercial aniline; but then the colour produced is no longer blue, but varies from blood-red to blue-violet, passing through all the intermediate shades according to the proportion of toluidine; it is therefore important, in order to avoid error, to employ products exempt from chlorine. It is really surprising how little chlorine will suffice to turn aniline blue in the presence of nitric acid, and the colour, at first feeble, augments in intensity. This remarkable fact is easily understood, on reflecting that in the presence of nitric and sulphuric acids, of the concentration indicated, the chlorine must necessarily be indefinitely regenerated, and that by the same rule its action must be multiplied an hundred-fold.

The fact which I have described shows how delicate are the reactions, in consequence of their extreme sensibility, and that in order to avoid errors in observation, it is necessary to employ pure reagents.—*Comptes Rendus.*

DETECTION OF NITRATES IN WATERS.

BY THOMAS P. BLUNT.

THE following test for the presence of nitrates in a drinking water is a little more delicate than the com-

mon one with ferrous sulphate; it depends on the reducing action exercised by sodium amalgam on nitric acid.

It was found that when a moderately concentrated solution of nitrate of potassium was poured over an amalgam of sodium containing about $\frac{1}{2}$ per cent of the metal, there was no evolution of hydrogen, and on pouring off the supernatant fluid after some minutes, and applying the Nessler test, a considerable quantity of ammonia was detected. A solution of pure nitrate of potassium, containing 1 part in 1000, was then prepared, and measured quantities were added to different portions of $\frac{1}{2}$ per cent sodium-amalgam, consisting of about 200 grains each; it was thus found that 20 grain measures of nitrate solution, representing 1-50th grain of the salt, gave a just perceptible colouration with the Nessler test after standing over the amalgam for about twelve hours; 40 grain measure (= 1-25th grain salt) gave a marked reaction. Several attempts have been made to adapt the above test to the estimation of small quantities of nitric acid; they have at present, however, been unsuccessful, through the impossibility of pushing the reaction to completion; it is possible, however, that a system of comparative testing analogous to that at present adopted in the case of ammonia may lead to some results. As an example of the mode of applying the test qualitatively to a drinking water, the following account is given of an actual experiment:—

To 2 ounces of a water known to contain a trace of nitrates, was added about 100 grains of a solution of hydrate of potassium, containing 1-12th of its weight of alkali; the whole was then evaporated nearly to dryness; thus any ammonia already existing in the water would be expelled. The residue was exhausted with distilled water which gave no reaction with the Nessler test, and the quantity of the solution made up to 200 grain measures, which were afterwards divided into two equal portions. One was at once tested with ferrous sulphate solution and sulphuric acid: a very faint brown colouration appeared at the point of junction of the layers of liquid, increasing considerably after a few hours.

The second portion was introduced into a carefully cleaned test-tube, with about 200 grains of $\frac{1}{2}$ per cent sodium amalgam: the tube was lightly corked to check diffusion of the ammonia formed as far as possible, but not so tightly as to prevent the egress of the hydrogen, which in dilute solutions of a nitrate is always evolved from the amalgam. The whole was left for about twelve hours: the liquid was then rinsed with successive portions of pure distilled water into a glass cylinder about 6 inches high and 1 inch wide, and the quantity was made up with distilled water to about 1000 grains. On adding about 15 grain measures of the Nessler test, a very strong colouration, accompanied by incipient precipitation, at once appeared. It is to be remarked that the liquid must always be decanted from the amalgam before applying the Nessler test, as the presence of nascent hydrogen appears to interfere with the action of the latter.

Shrewsbury, Oct. 12, 1863.

ON THE REDUCTION OF OXIDE OF COPPER TO THE STATE OF METAL BY MEANS OF INVERTED SUGAR.

BY M. A. COMMAILLE.

UNTIL the present time it was believed that the reducing action of sugar on salts of copper was arrested at

the protoxide (Cu_2O), and that it was impossible to obtain the metal as such, when under similar circumstances a salt of bismuth was substituted for salts of copper in which case metallic bismuth* was precipitated.

All the oxygen combined with the copper may, however, be removed by means of inverted sugar, but the metal is sometimes obtained pure, and sometimes as a mixture of copper and protoxide, according to the state of the liquid. Sometimes the copper presents the roseate appearance of galvanoplastic copper; at other times it will be much duller, but acquire brilliancy from polishing.

In order to obtain the reduced copper, take a very dilute solution of that metal and pour into it sufficient caustic potash to produce a precipitate; add to this liquid a solution of inverted sugar, and the precipitate will dissolve; the solution, which should not be acid, is then boiled; and after a short time a red deposit of protoxide is formed, which must be separated. The liquid is again boiled, and a fresh precipitate appears, which is proved to be formed of metallic copper and protoxide, which latter is removed by very weak chlorhydric acid; the undissolved precipitate is dried and polished with some hard body, when it presents the brilliant aspect of metal. On boiling the mother waters, by which the second precipitate was deposited, a third deposit is obtained, consisting only of metallic copper, and as red as galvanoplastic copper.

This metal may also be instantly obtained by the following method, without any mixture of protoxide:—

Before reducing the precipitate produced by the potash in the sulphate solution, by means of the inverted sugar, neutralise the acidity of the sugar solution, and when the precipitate of the copper hydrate is almost entirely redissolved, filter it, and boil the limpid liquid thus obtained; the metallic copper will then be seen to fall, but its colour is not quite so bright as in the former experiment.

I found it impossible, when working with M. Frommherz's liquid under ordinary circumstances, to obtain metallic copper; nevertheless it appears to me necessary to be on one's guard in saccharometry against the possibility of the complete reduction of oxide of copper.

ELECTRIC ILLUMINATION. SUNDRY EXPERIMENTS RELATIVE TO THE PRODUCTION OF ELECTRIC LIGHT.

BY F. P. LE ROUX.

THE brilliant phenomenon, now popularly known by the name of electric light, was first discovered by Davy; who, in 1813, conducted the current of a powerful pile between two pieces of charcoal. For more than half a century mankind has been dazzled by this light, whose brilliancy is comparable only to the sun, and yet many theoretical questions as to its intimate nature remain to be solved, and many practical difficulties with respect to its extended employment to be removed. The experiments which form the subject of this article may be found interesting from both points of view.

On the Nature of the Voltaic Arc.—In order to examine in detail, and without fatigue, what takes place between the two pieces of charcoal in Davy's experiment, the phenomenon should be projected upon a screen, that is to say, an augmented image should be produced by means of a lens, an experiment which is now common. Two salient traits of this phenomenon

* M. Stolba obtained metallic copper by means of glucose.

will now be remarked; on the one hand, the vivid incandescence of the points of charcoal, which glow with the brilliancy of the sun; on the other, the soft bluish clearness of the intervening space.

This bluish space generally presents the appearance of a conical trumpet, whose larger extremity rests upon the positive, and its lesser upon the negative point of charcoal. The slightest breath will alter the shape of this bluish light, which curves from its centre in an opposite direction to the breath, while its extremities continue to rest on the most incandescent points of the charcoal; this has led to the conclusion that it is produced by a highly rarefied substance extending between the charcoal poles.

At the time these experiments were first made it was usual to arrange the charcoal points in a horizontal line, where the ascension of currents of heated air naturally produced the incurvation above described, and led to its receiving the name of the voltaic arc; this name it still preserves, although it is no longer justified by the external appearance of the phenomenon, owing to the vertical arrangement of the charcoal now general.

The voltaic arc may be distorted or even broken by the proximity of a magnet; the sensible effect of a magnet on the arc is similar to that which it would have on a highly flexible circuit, permeated by the same current as the intervening space. It is evident that the voltaic arc is exactly the route taken by the electric current in passing from one point of charcoal to the other.

A glance at the whole phenomena will suffice to show that the quantity of light proceeding from the arc itself is minimum, and that the incandescent surface of the charcoal is the true source of the so-called electric light; but the portions of that surface, where the incandescence is incomparably more vivid than elsewhere, are the extremities of the sticks of charcoal, just at the places between which the arc extends.

What then is this arc? It is evidently composed of that constituent of the charcoal, which experience has shown to be conveyed from one point to the other. What form then does this matter take during its passage? Is the carbon merely disseminated as an excessively fine dust, or in a state of gas? This has not as yet been definitively answered, but some experiments which will presently be described, tend to cause the belief that carbon exists in the arc under the form of vapour.

One circumstance which is immediately perceived on examining the pieces of charcoal is the great difference in their temperature. The positive charcoal is considerably more luminous than the other, and its incandescence extends over a longer duration. I am even inclined to believe that the negative charcoal is heated almost entirely by the radiation of heat from the positive charcoal on one hand and the arc on the other, and by the heat proceeding from the condensation of the matter conveyed by the latter. I have made one experiment of a very simple kind, but which, however, I have never heard described, which will show that the heating of the positive pole is owing to a special cause, the seat of which is the exact point where the voltaic arc joins the charcoal. The experiment consists in this:—The charcoal electrodes are first brought into contact in the ordinary manner, and then separated so as to produce a very short arc of only a small fraction of a millimetre, which is interrupted at the end of some seconds; the positive electrode will then be found to remain incandescent for some time, whilst

the extremity of the negative electrode will be scarcely red. By this mode of operation the heat evolved by the arc is almost entirely eliminated, as the latter from its shortness offers feeble resistance, and is consequently the seat of but a slight disengagement of caloric. If, on the other hand, the extremity of the positive charcoal be really the source of evolution of caloric, one would suppose that the caloric would communicate itself more rapidly by interior conduction to the mass of the positive charcoal than by radiation to the negative charcoal, and that if the passage of the current were interrupted for a few moments, a marked predominance of the first of these effects would be apparent; this, the experiment shows to be the case. There exists, then, at the positive pole, a special source of evolution of caloric hitherto unexplained, but which does not, to me, appear inexplicable; I shall, however, revert to this subject in a special publication.

Employment of a Current of Oxygen for Disposing the most Luminous Portions of the Charcoal to greater Advantage.—It has just been remarked that the greater proportion of light arises from those portions of the surface of the electrodes, between which the arc arises; that of the positive pole is slightly concave, that of the negative more or less convex; that of the positive pole exceeds the other both in size and brilliancy. As it is usual to arrange the electrodes in the same vertical line, the illuminating surfaces in question are necessarily presented obliquely with regard to a horizontal direction, which is generally that in which the light is used. If from defective homogeneity of the charcoal, or any other cause, these surfaces should bend in any direction, the illuminating power will be seen to vary in that direction also. With such charcoal as that produced by gas retorts, the only kind now obtainable in the present state of commerce, and very impure, the disturbance of the arc is perpetual, and in photometrical measurements, the illuminating power of an electric lamp is seen to vary at each moment within extensive limits. I believe that if the arc could be made to remain always inclined in a given direction—that is, towards the side on which the maximum of light is desired to be thrown—that the steadiness of the light would be secured; this was satisfactorily proved to be the case; the arc being forced to incurve, the surfaces which formed its base were so much the more vertically inclined, and the light thereby more clearly directed towards the region desired to be illuminated. It is particularly necessary that the current of gas should incline the electrodes in a different direction to that in which the arc is bent, otherwise they will approach each other too closely, and the arc, choosing the most direct road, will also change its position. It is exactly this combustion of the charcoals, which is performed by a current of gas, which turns them towards two eccentric points, between which the arc naturally maintains itself so easily that the slightest force is sufficient to incurve it as we have described. The gas pipe should be placed at about 1 centimetre from the charcoal electrodes, and slightly below a horizontal plane passed between them, in order to combat the tendency acquired by the gas as it heats to flow in greater quantity towards the upper electrode. A good result is obtained by causing the gas to escape by two holes of about 1 millimetre in diameter, and 1 millimetre apart; the consumption of oxygen is not great, and may be estimated at about 15 litres per hour. It is of course understood that the conditions must vary with the size

of the electrodes and the force of the electric current employed, the stream of gas being weaker and weaker in proportion to the diminution in the size of the electrodes.

I should recommend all who desire to put this experiment into practice to carefully isolate the tube containing the gaseous current, as without this precaution the arc might come in contact with it and cause its instantaneous destruction.

Arrangement for Subjecting the Voltaic Arc to Spectral Analysis.—The image of the voltaic arc and luminous electrodes being already thrown upon a screen, let us conceive a small opening to be made in that part of the screen upon which the arc is projected, and thus an extremely simple means is obtained of isolating the light emitted by the arc from that of the electrodes. By placing the slit of a spectroscope behind this opening the character of the light emitted by gaseous substances is instantly perceived—namely, discontinuity. The spectrum of the voltaic arc is perhaps the most beautiful spectacle offered by the spectroscope; it appears to me to resemble most the spectra observed by MM. Plucker and Hittorff* during the combustion of cyanogen in oxygen, and also by M. Morren in that of carbon.†

I intend to make an exact determination of this spectrum as soon as it is possible to use a purer carbon than the charcoal of gas retorts; at present we can do no less than infer the presence of gaseous carbon in the voltaic arc. The proceeding just described may perhaps be also applicable to the examination of different portions of other kinds of flame; it will be only necessary to place a screen at the distance of about a few millimetres from the slit of the spectroscope, and to there project by means of a lens, the image of the flame to be examined; by this means it may be ascertained at any moment what part of the flame is under the spectral analysis.

Spontaneous Reappearance of the Voltaic Arc after an Interruption of Short Duration.—About twenty years ago, M. de la Rive, when studying the effect of magnetism on the voltaic arc, succeeded in producing it between bars of soft iron; he then observed that under certain conditions the arc was sometimes broken by the influence of an electric current circulating around these bars, but that if the disturbing influence was removed before the poles had cooled, the arc sometimes reappeared without obliging him to bring the poles into contact.

Ten years later, M. Wartmann, of Geneva, in experimenting on the practical application of electric light, proved that "it was possible to suspend the circulation of electricity between two charcoal electrodes during 1-20th of a second, without, he says, the arc disappearing.‡

M. Wartmann considered that, for a certain time after the interruption of the current, certain solid particles remained interpolated between the two poles. I was led to a more detailed study of these phenomena, by endeavouring to give some description of the production of electric light by means of magneto-electric machines, in which case the current changes, as is well known, many times in a minute, and must therefore of necessity pass by zero—that is, it must be interrupted.

The first question to be asked is, Is the arc really interrupted at the same time as the current? Observation has proved that the arc really ceases to exist during the interruption of the current; the following is a convenient method of demonstrating it to a numerous audience.

At the end of a pendulum, beating about every half second, is suspended a screen upon which the reflection of the electrodes is thrown by means of a lens; by this contrivance the reflection of the electrodes is displaced upon the screen. Consequent upon this is the displacement of the image formed upon the retina, whose sensation is thus rendered less obtuse than it would be were the image continually in the same place, and the changes of short duration which the object under examination may undergo are more easily perceived.

These arrangements being finished the two electrodes are placed at a distance from each other of about 2 millimetres, and there fixed (if they be mounted on a regulator the movement must be stopped), and the current is then interrupted by the hand for a period not exceeding 1-20th of a second. This interruption may be more easily made by a spring plate working against a catch, the arrangement being such that the separation may be made by a downward movement.

It will be clearly perceived that the violet light constituting the arc disappears at the moment when the current is interrupted.

This interruption may be repeated a large number of times per second (we shall presently recur to the use made of this fact in the division of electric light) so that the electrodes may be examined during the length of the interruptions only, by an apparatus somewhat resembling the phosphoscope of M. Edm. Becquerel; the interruptions are effected by the apparatus itself, and thus the condition of the intervening space may also be examined during the same period. Economical motives have hindered me from realising this project, and I may here add that the kindness of M. Serrin first enabled me to effect the experiments which form the subject of this communication.

On a Mode of Dividing Electric Light.—The fact here admitted as the result of experience that, in order to produce electric light most advantageously, it is necessary to employ a considerable number of elements arranged in series, may be of some theoretic consideration; operators usually employ fifty elements of Bunsen. Light may be produced by a much smaller number—twenty, for instance,—but the quantity of light produced is proportionately less, and the working condition arising from length of arc, regular consumption of charcoal, and exhaustion of pile, is much less favourable than when a larger number of elements are used.

On the other hand it is an advantage in many cases to be able to distribute the entirety of light yielded by a pile or electro-magnetic machine into several distinct lamps.

The only means which have been hitherto tried to my knowledge are, after dividing the source, the introduction of several arrangements into the same circuit, and the bifurcation of a single current into several lamps.

Thus, as to the division of light into two burners, and supposing the source to be a pile of fifty elements, either of the three following dispositions may be made.

1st method. Dividing the source.—Compose two piles of twenty-five elements each, and conduct each to a special electric burner.

2nd. By succession of burners.—Dispose the fifty ele-

* Plucker and Hittorff. *Philosophical Transactions*, 1865.

† A. Morren, "On the Flame of some Carburetted Gases." (*Annales de Chimie et de Physique*, 4th series, vol. 4, 1865.)

‡ *Bibliothèque Genève* (Archives des Sciences Physiques et Naturelles, vol. 36, page 325, 1857.)

ments in tension, and conduct the same current through the two arrangements successively.

3rd. Bifurcation.—Retain the fifty elements in tension and direct the current into two arrangements. We have already stated that the first system of two small piles was less advantageous with regard to the entirety of light than the ordinary system of one.

The second system has no advantage over the first, but possesses the disadvantage that if by any means the condition of one of the burners be altered, the other will sympathise; therefore, as from the very nature of all regulating apparatus hitherto known, the movement of the charcoal depends on the intensity of the current; movements induced by the state of the electrode in one regulator, will indubitably occur in the other if they be really equal. If one were more sensitive than the other it would be always separate, and consequently there would sometimes be a contact of the electrodes, and sometimes a rupture of the arc from too great elongation.

The third system by bifurcation or derivation has not the same drawbacks; the two arrangements do not influence each other in the same inconvenient way, but fall under the same conditions as to intensity as in the method of equal division of the source.

I have meditated dividing the current into periods, in order to separate the light into spaces, profiting by the power possessed by the arc of spontaneous re-establishment after an interruption of short duration.

Let us suppose that by means of appropriate mechanism the current is made to pass into one arrangement during 1-100th of a second, then during the next 1-100th into another arrangement, and again back to the first during the next 1-100th, and so on. As the duration of the interruption is short, the arc re-establishes itself spontaneously; and as it is also weaker than the permanency of the impression received by the retina, the arc itself being but a feeble source of light, the eye will consequently receive a sensation of continuity; moreover the incandescence of the electrodes varies only slightly. It is not to be denied that this experiment presents more theoretical than practical interest on account of the complication involved by the mechanism necessary to divert the current into sundry arrangements, nevertheless in some cases it may be found useful. The chief difficulty in applying it arises from the destructive action upon the distributive wheel of the sparks which arise in consequence of vibrations which it is impossible to quite avoid; the contact separates from the surface of the wheel; these sparks, which are so many voltaic arcs formed at the expense of the opposing surfaces, corrode and render them unequal, and aggravate the causes of interruption.*

If the apparatus works regularly the sparks will be feeble, but they will be altogether fatal if one of the burners should act alone, and this vexatious occurrence should be above all avoided, which may be easily done by arranging in such a way that if by any means one of the burners should be extinguished, the current should still find an outlet on that side.

* Experience has proved, in contradiction to a generally believed opinion, that it is better not to lubricate with any liquid the friction produced by the contact with the wheel; greasy bodies inflame at each spark, and thus augment its destructive effects by means of the developed heat; moreover, wear is not completely avoided, and the grease agglomerates the detached metallic particles in an inconvenient manner. In the dry friction the wear is more rapid, but it is regular, and the metallic dust is carried off by the disturbance of air; the general rule against the friction of two identical metals against each other must of course be obeyed, and the red copper contacts will succeed very well with the bronze wheel.

To render the sparks as harmless as possible, it is a good plan to multiply the contacts, it being apparent, that if instead of one spring we substitute two or more, there will be some chance that at least one may be always in perfect contact with the wheel. This, however, will not be the case if a cause of displacement, common to all, should arise, which is exactly what happens at every change in the teeth; for this reason only a small distance, not more than a millimetre, should be left between any two consecutive teeth, and the contacts should be arranged so as not to leave one tooth until they have slightly touched upon the next.

The surface of the contacts being more easily repaired than that of the wheel, it is preferable to cause communication between the former and the positive pole.

The vibrations of the contacts may be lessened with some success by mounting them upon springs composed of several thin plates, alternated with layers of gutta-percha.*

Combination of the Incandescence of earthy Oxides with that of the Charcoal Points between which the Volatile Arc is Produced.—In applying electric light the method generally proposed is to direct it into a more or less limited region of space; all which escapes into the opposite region would be lost if it were not collected by reflectors more or less appropriate to the purpose. On the other hand, experience has proved that the voltaic arc is prone to irregular displacements, consequent upon inequalities in the cohesion of the charcoal, impurities contained in it, and above all the slightest agitation of the air. The most luminous portions of the charcoal electrodes being, as we have already remarked, the surfaces between which the arc arises, these surfaces are inclined sometimes in one direction and sometimes in another by reason of the displacement which the arc undergoes, the result being a considerable variation in the effect of light produced by the latter in any determinate region.

I believe that if there could be placed on the opposite side to that towards which the light was to be directed, and in proximity to the arc, some body capable of reflecting back in a luminous form the enormous number of radiations thrown upon it by the electrodes and the arc itself, these radiations would be more profitably utilised than by any other method, the arc being at the same time protected by a sort of screen, annulling in an almost hemispheric region all the above-mentioned disturbing causes.

The substance chosen for such a purpose should be at the same time a bad conductor of heat, and possessed of great powers of radiation, conditions fulfilled to a great extent by lime, magnesia, and earthy oxides in general. I first effected the experiment with cylinders of magnesia compressed according to the process of M. Caron, and manufactured for purposes of oxyhydric illumination. By placing the base of one of these cylinders, whose diameter is about 8 millimetres, at a short distance from the charcoal points of an electric lamp, in such a way that the magnesia may be, as it were, licked up by the voltaic arc, it will assume an

* These considerations of course apply to cases where a pile is used as the source of electricity; if a magneto-electric machine be employed, it must be arranged in a peculiar manner. The mean tension of the machines usually employed is known to be so weak as to produce only an arc of short extent, and as experience shows that the bifurcating system described necessitates a reduction in the length of the arc, the machines should be so managed as to present a higher degree of tension; it will be as well to arrange the distribution in such a manner that it should occur at the moment when the current is at the minimum in order to avoid the intensity of the sparks.

incandescence equal to that of the most luminous portion of the charcoal. At the same time the light acquires remarkable constancy from the fixity of the arc, which may be drawn to greater length than in ordinary cases, because as the magnesia forms a screen and maintains the elevation of the temperature, the chances of the arc being broken are greatly diminished.

The magnesia may thus be kept in contact with the voltaic arc for more than an hour without sufficient consumption to cause any apparent change in the conditions of the experiment; its surface becomes hollow during the first few moments, but if the bar of this substance is kept fixed, the power of the arc abating at a very slight distance, it will no longer be consumed. Another kind of alteration will, however, ensue, the magnesia will imbibe the siliceous vapours emitted by the voltaic arc, and combine with them in a sort of glass, which, when cold, is of a pale greenish hue, and extremely hard. This fact is disadvantageous, inasmuch as it greatly diminishes the irradiating power of the magnesia, and renders the production of a commercial pure carbon in an appropriate condition for the purpose of electric illumination still more desirable.

The arrangement of a brilliant voltaic arc between two pencils of charcoal, and in the presence of magnesia or any other earthy oxide, would constitute one of the most beautiful sources of light possible to realise. It is probable that zirconia, whose remarkable properties with respect to the oxyhydric flame have been made known by M. Caron,* would be equally beneficial in the case of electric light; but at present I have had no opportunity of trying it. It may nevertheless be inferred that zirconia would, like magnesia, be quickly vitrified by the siliceous vapours of the charcoal, so that considering the high price of zirconia, it would be expensive to use unless the carbon were free from silica.

Decomposing Action of the Voltaic Arc on Earthy and Alkaline-Earthy Oxides.—When that splendid experiment which has since become familiar to us, though on a smaller scale, was performed by Davy with the pile of the London Royal Institution, he proved that the most refractory substances, such as magnesia, lime, and other oxides of the same kind, melted or even disappeared in this focus of intense heat.

Neither Davy nor any later experimentalists appear to have ascertained the nature of the alteration caused in the oxides by the action of the voltaic arc; the pursuit of other investigations has led me to a more attentive consideration of these phenomena, by which I have discovered that the oxides undergo a real decomposition. The advantages derived from the juxtaposition of a cylinder of magnesia to the charcoal points, for providing electric light, have been already alluded to; it may be added that lime or strontia will do equally well. If the cylinder of either of these substances be fixed, a slight cavity instantly forms at its base, and the conditions remain the same for an indefinite time, the arc continuing to play upon the body without inducing any modification but the vitrification caused by the siliceous vapours emitted by the impure charcoal. If, however, the cylinder of earthy matter be brought into actual contact with the charcoal points, and the pressure maintained by a slight spring, the aspect of things is changed.

If a pencil of lime or even plain chalk be used, the

carbons will hollow out in it a sort of trench in which the heat is condensed as in a sort of reverberatory furnace, and the amount of light emitted is proportionally augmented. On examining the light with a piece of black glass it presents the appearance of an opaque luminous cloud in which the extreme ends of the charcoal are undistinguishable, their usually well-marked brilliancy being lost in the mass of light, and there is a sensible evolution of whitish fumes. The spectroscopic displays an intermittent spectrum filled with large and brilliant rays which are recognisable as those described by different authors as characteristic of calcium, but their number and intensity is greater and they are better defined. This is not surprising if the difference between the luminous intensity attainable by this process and by those hitherto employed be considered.* It would be doubtless possible by this method to obtain much new information respecting the spectra of metals, provided that only pure products were employed.

The employment of strontia gives analogous effects under the same conditions, the light assumes a characteristic red tinge, and the spectroscopic displays the rays characteristic of strontium, thus presenting a simple means of enriching the electric light with red rays. It may be here remarked that the flame always contains a large proportion of white light, for if the metal be set free in some parts of the flame, in others it returns to the state of oxide, the incandescence of which always yields a white light.

After this it can no longer be doubted that earthy and alkaline-earth oxides undergo decomposition by the voltaic arc; it now remains to be ascertained by virtue of what action it takes place. Is it an electrochemical deposition? Does the oxide become a conductor by the elevation of temperature? Is it a reducing action of carbon vapour?† or lastly, is it, according to the theory of M. H. Sainte-Claire Deville, a result of elevation of temperature producing a separation of the elements in the same way as when oxide of mercury is heated? Do these three causes operate simultaneously? which is quite possible, or may one be wanting? I cannot say; but it appears to me that two may be suppressed: it is known to be possible to produce with solar light, concentrated in a focus of mirrors or lenses, a heat quite as powerful as that of the voltaic arc, and spectral analysis may be easily applied to these phenomena; to realise this idea, special conditions would be required not easy to improvise, but, nevertheless, I hope when possible to put it into effect.

Nothing can be easier than the practical application of the modes of improving the quality of electric light. Arrange in the horizontal plane which passes between the charcoal points a tube formed like a cylinder, from 8 to 10 millimetres in diameter, containing the oxide to be employed; this is kept in constant contact with the charcoal by a weak spiral spring. Experience shows that the slight friction which ensues does not prevent the action of the apparatus which regulates the move-

* The spark from the batteries doubtless possesses a higher temperature than that of the voltaic arc, but its duration is very short and its impression upon the organ of sight is an example of the brevity of its duration.

† Observations made by MM. H. Sainte-Claire Deville and Debray in the course of their examinations of the metals of the platinum series, show that on the contact of gas-coke and lime, heated in a flame of oxygen and hydrogen gas, phenomena of reduction occurred; thus, lime which has been subjected to these conditions, when plunged into water, disengages hydrogen gas, and will even burn in the liquid. (*Annales de Chimie et de Physique*, 3rd series, vol. lvi., p. 399, 1859.)

* *Comptes Rendus*, vol. lxvi., p. 1050 (May, 1868).

ment of the charcoal. It is possible, if the oxide employed be excessively impure, that the vitrified matter would cause the charcoals to adhere to it; this might, however, be easily avoided by causing the charcoal to rotate slowly upon their axes.

ON THE PURIFICATION OF RAW ANTIMONY.

This purification is effected by melting the raw antimony, containing copper, arsenic, lead, iron, and sulphur, with oxidising reagents (saltpetre or antimonious oxide), and with purifying reagents (carbonates of potash and soda), in order to oxidise and scorify the foreign metals; or these metals (iron, arsenic, lead, copper) are sulphuretted by a small addition of sulphide of antimony or Glauber's salts and coal, and are transformed into sulphides, when they combine with the slag. An addition of chloride of sodium transforms these metals into chlorides, and as such they either volatilise or become scorified. Antimonious oxide decomposes sulphide of antimony thus:—



The carbonate of soda reacting as a flux also decomposes sulphide of arsenic, forming carbonic acid, arsenious acid, and sulphide of sodium. Sulphide of sodium fluxes with FeS , Cu_2S , and As_2S_3 , whilst the arsenious acid combines with soda. A repeated smelting with soda is required for a complete removal of arsenic, which is facilitated by the presence of a small amount of iron, as a combination similar to arsenical pyrites is formed. Sulphide of iron must be added if the raw antimony does not contain iron. The purifying smelting is effected in crucibles, in reverberatory furnaces, or in air furnaces. In order to furnish the ingots with the star-like appearance on their surface necessary for commerce, the metal must be allowed to solidify under a cover or star slag, and all movement of the moulds must be avoided.

At the Enthoven lead works, near London, the raw metal is sorted according to the amount of iron it contains, which is judged by the appearance of the fracture. The pieces rich in iron are smelted together with the poor pieces, and 70 or 80 lbs. of this admixture, together with common salt, are kept in a fused state for one or one and a half hours. The smelted metal is poured into hemispherical iron moulds, and broken after the slag has been separated; the pieces are then carefully sorted to obtain a suitable admixture, and purified by being melted in quantities of 60 or 70 lbs., with 1 or 2 lbs. of American potash and 10 lbs. of slags of the same process. After smelting it is stirred with an iron rod, and the state of purification judged by the appearance of the slag. When slag is lustrous, and of a deep black colour, the metal is poured into moulds, and kept covered with slag until it solidifies. One labourer can turn out from 15 to 17 cwts. of metal in twelve hours.

At Septèmes and Bouc each crucible is charged with 44 lbs. of raw metal, 12 or 16 lbs. of sulphate and carbonate of soda, mixed with some common salt, and very pure oxidised antimonial ore. Twenty of these crucibles are kept at a moderate red heat on the hearth of a reverberatory furnace for six hours, consuming 4 or 5 cwts. of coal. The refined metal is poured into moulds, forming ingots 20 or 24 lbs. in weight; the slag is removed after the ingots have cooled.

Many other methods of purification have been recommended. For instance, Wöhler heats the metal with one part of sulphide of antimony, one and a quarter

parts of saltpetre, and one and a half parts of potash, and lixiviates with water for the extraction of arseniate of potash; he then reduces the residue with half a part of tartar. Meyer recommends heating with a quarter of a part of soda-saltpetre, and half a part of carbonate of soda, washing with water, and melting the residue with tartar. Schiel recommends the melting of sixteen parts of regulus with one and a half parts of soda, repeatedly adding some saltpetre, and stirring with a clay rod. Berzelius melts two parts of metal with one part of oxide of antimony. Muspratt melts four parts of antimony with one part of manganese, and repeatedly melts the resulting regulus with 0.1 part of potash.

ON SOME POINTS IN CHEMICAL GEOLOGY.

BY DAVID FORBES, F.R.S., &C.

IV.

The Constitution of the Interior of the Earth.—Although we are naturally precluded from directly investigating more than the mere external contour of the globe which we inhabit, the nature of its interior must ever be of the highest interest and importance in chemical geology, since whatever be the hypothesis as to its composition and character which is accepted by the chemist or geologist, it cannot fail to influence greatly the general tenour of his reasonings as a whole.

The long and widely received doctrine, that the interior of the earth is still in a state of molten liquidity, is a deduction from the numerous data collected by an extended study of the various terrestrial phenomena, which form the subject of geological inquiry.

The direct evidence afforded by the frequent and great outbursts of molten lava, which in every quarter of our globe are met with, breaking through the surface of the land and disturbing the bottom of the sea, and which moreover present in all parts of the world, however distant from one another, the same general features of mineral and chemical composition, could not but lead to the very natural inference that these eruptions must proceed from some vast internal accumulation of molten matter, situated at comparatively no very great distance below the surface.

Such inquiries, therefore, led to the hypothesis that the earth is in reality a molten fluid mass enclosed within or bounded by a relatively thin crust or shell which forms its present surface; whilst astronomical and geodetical investigations into the true figure of the earth, further pointed out the probability that this state of things had originated in the external cooling of a sphere of molten matter in rapid revolution around its axis.

The late Professor Hopkins, of Cambridge, was the first who brought forward any serious objection against this all but universally received hypothesis, declaring in a series of memoirs published in the transactions of several learned societies, that by employing a line of reasoning founded on mathematics and astronomy, he had proved this hypothesis to be inconsistent with the known phenomena of the precession and nutation, which, according to him, would require that the external crust of the earth should possess a thickness of not less than 800 to 1,000 miles.

This system of reasoning was subsequently followed by Archdeacon Pratt in his work on the figure of the earth (edition of 1860), and still later by Professor Thomson, of Glasgow, in a memoir on the rigidity of

the earth (*Philosophical Transactions*, 1863), where the conclusion arrived at is that the earth if not solid to the core must be nearly so, the summing up (page 573) being, "That no continuous liquid vesicle at all approaching to the dimensions of a spheroid 6,000 miles in diameter, can possibly exist in the earth's interior without rendering the phenomena of precession and nutation very sensibly different from what they are."

This, if it may be so called, mathematico-astronomical deduction, notwithstanding its being so diametrically opposed to the previously received hypothesis, which was professedly the conclusion arrived at from a prolonged study of terrestrial phenomena, does not appear to have been disputed or even questioned as to the correctness of either its premises or arguments, and seems to have been at once accepted by a class of chemists and geologists, who, either unwilling or incompetent to take such problems into mature consideration, are always ready to adapt their opinions, like their garments, to the latest fashions.

The natural sciences, however, are assuming each day a more and more exact character, and their true and sure advancement demands that no doctrine whatsoever shall be taken for granted, even when put forward, as in this case, by the most eminent authorities, until the evidence for and against it has been thoroughly scrutinized and the balance shown to be in its favour.

The conclusion as to the entire solidity of the earth put forward by these distinguished mathematicians and astronomers, although, as before said, accepted by many, has, however, its opponents, and amongst them several very eminent men of science, who still hold to the old hypothesis of its internal fluidity.

Thus, in the discussion on underground temperature at the recent meeting of the British Association at Norwich, Mr. Sartorius Von Waltershausen, so well known in connection with his researches on volcanic phenomena, declared that from his recent calculations he believed that the thickness of the earth's crust was only 14 geographical miles, and gave as his further opinion that at the time of the first formation of the seas on the face of the globe it did not exceed 50 metres.

The attempt to decide such scientific problems merely by reference to authorities, or in other words to bring in the *argumentum ad hominem*, is a deplorable mistake; such questions must be decided upon their own intrinsic merits, and if the explanation or hypothesis is true, no number of distinguished men are needed in its support; whilst, if false, their names may possibly retard, but cannot prevent its ultimate rejection.

The data upon which the hypothesis of the internal fluidity of the earth is based are so numerous, and at the same time so thoroughly tangible and self-evident, that it would appear unjust to throw this theory overboard at once, merely upon the strength of a single argument advanced against it from the regions of astronomy; at least, not until this objection had been thoroughly examined into and proved correct.

Such a scrutiny, however, was beyond the powers of the mere chemist or geologist, since it entailed a more than ordinary knowledge of mathematics and astronomy seldom likely to be at their command, and they therefore cannot but feel highly gratified to find that the question has at last been taken up and thoroughly investigated, both theoretically and experimentally, by so competent an authority as the author of the *Mécanique Rationnelle*, M. Delaunay, a man of science equally eminent as mathematician and astronomer.

In a memoir,* read before the French Academy, the 13th July last, M. Delaunay has taken the results obtained by Professor Hopkins, Archdeacon Pratt, and Professor Thomson, into mature and minute consideration, and the conclusions he has arrived at are—that the objections which have been brought forward and supported by these eminent mathematicians and astronomers, against the hypothesis of the internal fluidity of the terrestrial globe, are not founded on any true basis whatsoever, or to use his own words "ne repose sur aucun fondement réel," and further that the phenomena of precession and nutation cannot furnish any data for determining the thickness of the earth's crust:—"la considération des phénomènes de la précession et de la nutation ne peut fournir aucune donnée sur le plus ou moins d'épaisseur de la croûte solide du globe."

In arriving at these conclusions, M. Delaunay fully admits the universally received facts and explanations of the phenomena of precession and nutation, and does not even object to the mathematical part of the investigation* employed by his opponents, but confines himself to demonstrating experimentally, as well as by argument, that the premises from which they started in their inquiry, and upon which their deductions naturally be based, were in themselves essentially unsound and untenable.

These premises consisted in taking for granted the behaviour of an entirely solid globe, in its relations to the phenomena of the precession and nutation, would be materially different from what that of a globe would be in the case it were merely composed of a solid external crust or shell filled with fluid matter.

Mr. Delaunay then points out that this view has been adopted upon the supposition that liquids are endowed with the property of *absolute fluidity*; in which case, if a globe filled with such a liquid was suddenly set in rotation around its axis, the external shell should alone revolve, without at all carrying the liquid along with it, which ought to retain its pristine immobility.

No one except a true mathematician could form in his mind such an abstract idea of a liquid, and whilst admitting its *absolute liquidity*, forget that, however feeble it may be, still that no liquid whatsoever is absolutely destitute of *viscidité* or *viscosity*, a fact which easily explains why the liquid interior of the globe would be carried round along with the solid shell which enclosed it, the whole revolving together just as if the liquid had been congealed, and along with its retaining envelope actually formed one entirely solid body.

Even if it be advanced, that at any particular epoch a difference might have existed between the rate of movement of the crust and that of the liquid interior, the resulting friction must gradually have obliterated this difference and brought about an absolute conformity between the motion of the solid and liquid parts.

In order fully to appreciate the clear and sound line of reasoning employed by Mr. Delaunay in solving this problem, his original memoir must be consulted; from this it will be seen, that he has not been content merely with having proved his points by argument alone, but that by the construction of an experimental model he has fully removed any doubts which might have

* A translation of which will be found in the *Geological Magazine* of November, 1868.

† Professor Thomson (*Philosophical Transactions*, 1863, p. 573), whilst he agrees with Mr. Hopkins in the force of his arguments, appears to differ with him on this head, remarking "Although the mathematical part of the investigation might be objected to."

sequently suggested themselves as likely to affect the validity of his conclusions. The objections brought forward by Professors Hopkins and Thomson, as well by Archdeacon Pratt, may be therefore considered explained away, and until further proof is brought forward to the contrary, we may still regard the hypothesis of the internal fluidity of the earth as representing the result of geological enquiry upon this subject posted up to date.

Solidification of the Terrestrial Globe.—Whatever may be the difference of opinion as to the nature and composition of the interior of the earth, there appears, however, to be almost perfect accordance amongst men of science in general as to the hypothesis that the terrestrial globe was at one period in a state of molten liquid; and the more recent researches of astronomers on nebulae and other celestial bodies, in which the spectroscopic has been of incalculable assistance, further adds to support the nebulous theory of its origin, which explains the production of such a molten sphere by the condensation of previously gaseous matter.

In considering the effects of the cooling, and the subsequent solidification of this molten globe, opinions have been somewhat divided, the majority contending that, like most bodies with which we are acquainted, it would consolidate first on its exterior; others imagine that, owing to the enormous pressure to which the central portion must be subjected, the solidification would have commenced, first at the centre, and then gradually proceeded outwards to the external surface, which was the last to become solid; whilst others again, like the late Professor Hopkins, contend that the solidification would commence at once both at the centre and surface, so that at the same time there would be a central solid nucleus separated from an external crust by an intermediate zone of still fluid matter.

Professor Hopkins, who, as before observed, had arrived at the conclusion that the earth must be in great part solid, and who fully acknowledged the difficulty of explaining the sources from which the molten mass accompanying volcanic outbreaks proceeded, appears to have been the more disposed to adopt this hypothesis, from imagining that such a process of solidification would be likely to leave reservoirs of still fluid matter situated between the external crust and the internal solid nucleus from which he imagined volcanic matters are ejected.

This view of the process of solidification, simultaneous both from centre and surface, seems to be corroborated by the results of experiments made upon the melting points of bodies under pressure (although in the present state of our knowledge it is unwise to place too much dependence upon these experiments), whilst it seems quite impossible to imagine that the cooling of the surrounding atmosphere could fail to cause the formation of a solid external crust at the same time.

The only objection which has been brought forward against the probability of a consolidation at the surface is that the solid crust so formed, would be immediately taken up by its own contraction in solidifying, and being heavier than the fluid from which it had condensed, would sink down into it. This objection, however, is very easily encountered, especially when it is remembered that such a crust would solidify, as well for a long period remain, at a very high temperature, which would quite prevent its being likely to break up and fly to pieces as if it were to be cooled

suddenly to a greatly lower temperature; for this reason also such a crust would form a double-dome or spherical cover to the earth, the particles of which would mutually support one another.

Experiments have further proved, that in the cases of at least several substances which contract on cooling, these bodies, when in the hot expanded condition, are really lighter than when molten, as in the case of Bessemer steel, brought under my notice by Mr. Hackney, who found that the hot steel lumps floated about in the melted bath of the same steel; since then, however, I have been able, through the kindness of Dr. Lloyd of Birmingham, to prove that this is also the case with silicates such as glass, for when Dr. Lloyd at my request quietly laid solid discs of glass $9\frac{1}{2}$ inches in diameter and 1 inch thick, which weighed $7\frac{1}{2}$ lbs. each, upon the surface of a large potful of the same melted glass at fusing heat, they only partially sunk into and floated on the surface of the metal, until by degrees, after a very considerable time, they became ultimately absorbed in the vastly greater body of the melted metal on which they rested. Another circumstance must also be taken into consideration—viz., the actual condition of aggregation of a solidified crust formed on the top of an enormous body of silicates in fusion. Its surface would no doubt resemble the scorificious surface of the crater of a volcano full of boiling lava, or the vesicular froth or light scorificious mass which swims on the more dense slags in metallurgical operations; and this porous state of aggregation, upon the cooling of the globe to so low a temperature that water could rest upon its surface, would most materially contribute to its rapid disaggregation and breaking up, by the action of the water and carbonic acid contained in the primeval atmosphere of the globe.

Contraction which occurs upon the Consolidation and Cooling of Fused Silicates.—This is a point of considerable importance in inquiries of this nature, and whilst it is admitted that most, if not all, silicates do contract in passing from the heated to the cold state, or in other words that the solid cold rock occupies less bulk than it does when molten, opinions differ considerably as to the amount of such contraction in various rocks, principally for the reason that great difficulties are encountered in determining experimentally the actual difference in volume between the molten and solid substance operated upon.

Bischof has taken this subject into very detailed consideration, and as the result of a long series of experimental determinations gave (Leonhardt and Bronn's *Jahrbuch*, 1841) the following summary:—

	Volume in fluid state.		Volume in crystalline state.
Basalt	I =	0.8960	
Trachyte	I =	0.8187	
Granite	I =	0.7481	
	Volume in glassy state.		Volume in crystalline state.
Basalt	I =	0.9298	
Trachyte	I =	0.9214	
Granite	I =	0.8420	

By a simple calculation these figures may be placed in a more convenient form, as follows:—

	Volumes in the igneous or molten condition.		Volumes in the vitreous or colloidal condition.		Volumes in the stony or crystalline condition.
Basalt	1,000 . . =	963 . . =	896		
Trachyte	1,000 . . =	818 . . =	818		
Granite	1,000 . . =	748 . . =	748		

From the above figures it will be seen that, accord-

ing to Professor Bischof, the two rocks, granite and basalt, which form the extremes of the petrological series of silicated crystalline rocks, differ very greatly from one another in the amount of contraction which they respectively undergo in passing from the fluid to the solid state, since, according to him, granites suffer a diminution of above 25 per cent in volume, whilst basalts contract somewhat more than ten per cent when passing from the molten to the stony condition—results which lead to the inference that the contraction becomes greater in proportion as the rocks are more highly silicated.

According to these results, also, a mass of molten rock in the process of cooling, first contracts considerably when it passes into the glassy or colloidal state, and then contracts in a still greater degree before it attains the stony or crystalline condition.

This latter deduction I have experimentally verified in the case of several rocks, and amongst others that of the well-known so-called Rowley Rag stone of Staffordshire, which is a doleritic rock of the post-Carboniferous, but anti-Permian geological age; the composition of this basaltic rock, according to Henry, is:—

Silica	49.86
Alumina	12.75
Lime	8.71
Magnesia	4.39
Protoxide of iron	11.38
Sesquioxide of iron	3.36
Potash	0.57
Soda	5.25
Titanic Acid	1.33
Phosphoric Acid	0.58
Water	2.56

100.74

Mineralogically, it is composed chiefly of a soda-lime triclinc felspar, most probably Labradorite with augite, along with titanoferrite, and a green hydrous silicate, probably celadonite; it also contains traces of apatite, zeolites, &c.

The specific gravity of the Rowley Rag was found to be 2.84, which was the average of numerous determinations made on specimens of the perfectly unaltered rock, each from 2,000 to 6,000 grains in weight.

After fusion in a reverberatory furnace, and being allowed to cool under different conditions, the resulting products were found to possess respectively the following densities:—

1. Perfect black glass	(sp. gr.) 2.67
2. Less perfect ditto	2.71
3. Black glass showing a tendency to devitrification	2.73
4. Black glass enclosing devitrified spheres	2.75
5. Completely devitrified crystalline product	2.84
The original Rowley rag-stone being also ..	2.84

The above numbers are reliable, having in all cases been verified by several determinations on different fragments varying from 1,200 to 6,500 grains in weight.

These experiments were made in 1855, at the works erected by Messrs. Chance near Birmingham for the manufacture of Rowley Rag glass and devitrified castings, or so-called artificial stone, and as these works are now no longer in existence, I have since regretted that the opportunity was not then taken advantage of, in order to determine decisively the contraction actually sustained by this basaltic rock, when passing from the liquid into the solid or stony condition; for I retain

the distinct impression that it appeared then to be very much less than it should be, if the results of Bischof's experiments above cited were correct.

As the devitrified castings of Rowley Rag manufactured by Messrs. Chance were often of large dimensions, frequently blocks several feet in length and weighing upwards of half a ton, it occurred to me that an estimate of the relative amount of contraction would be obtained if the dimensions of the wooden pattern used in forming the mould were compared with the actual measurements of the devitrified block cast in this same mould. I therefore wrote to Messrs. Chance, begging them to assist me by taking the exact measurements of several of their largest castings, as well as of the wooden patterns from which they had been moulded. This they at once did with their usual kindness and desire to assist scientific investigation, and the result was soon after communicated to me by Mr. Alexander Chance in the following words: "Our Rowley Rag was always cast in red-hot sand moulds, so as to allow of the slowness of cooling necessary for the devitrification of the melted mass. We find that the stone thus produced is of precisely the same dimensions as the wooden pattern, showing no contraction whatever." Since, however, the moulds in which these castings were made were previously heated, no conclusive result can be deduced from the above facts, beyond the inference that it is extremely improbable that any contraction as large as 10 per cent (as maintained by Bischof for basalt) could have taken place.

In 1847, when at the Eidsfoss Iron Works in Norway, I attempted to throw some light upon this point by some similar experiments on the slags produced by the blast furnace there. These slags were extremely acid, and in round numbers their composition would approximate to—

Silica	60 per cent.
Alumina	15 "
Lime	17 "
Magnesia	2 "
Oxides of Iron and Manganese	1 "
Alkalies	5 "

100

The slags were allowed to flow into iron moulds 10 inches long by 6 inches deep and wide, also containing 360 cubic inches, a heavy iron top-plate being dropped upon them when overflowing, so as to ensure their being filled completely and evenly. When cold, these blocks differed so extremely little in external dimensions from the actual size of the mould in which they had been formed, that their contents were found to be in no case less than from 350 to 355 cubic inches, equal to a contraction of about from $\frac{1}{4}$ to 3 per cent only, instead of being more than three times that amount if we calculate according to the amount of silica contained in them, and the coefficients of contraction by Professor Bischof.

In 1849 and 1850 numerous experiments were made by me, conducted in a precisely similar manner (and in the identical same moulds used at Eidsfoss) at the Espedal smelting works also in Norway. In this case the slags were of a very different nature, being of two distinct kinds, both of which were more basic and contained more oxide of iron than the blast furnace slags; the composition of these slags being approximately—

Silica	42.30
Alumina	12.4

	I.	II.
Lime.....	5	2
Magnesia.....	9	1
Protoxide of Iron (with some Fe ₂ O ₃).....	27	59
Protoxide of Manganese, Copper and Nickel....	1	1
Alkalies.....	4	3
	100	100

The results of these experiments did not materially differ from those obtained in the case of the Eidsfoss blast furnace slags, and in 1856, in Birmingham, I likewise obtained very similar results when employing slags produced in the smelting of silver and nickel ores, in which experiments the iron mould was made large enough to contain a block weighing about 400 pounds. Further observations on the very basic slags of the Staffordshire blast furnaces and puddling furnaces poured into sand moulds also led to similar conclusions.

Such experiments add to our information on the subject under consideration, and point out the great probability that the actual contraction experienced by silicates is much less than generally estimated, still it must be admitted that they do not provide a certain means of determining the actual amount of contraction with any accuracy, for with the exception of the devitrified Rowley Rag* masses cast in hot moulds, the blocks of slags on breaking up were never found to be altogether free from cavities, due either to the enclosure of gases or possibly also to contraction.

In order to overcome this difficulty, I proposed making similar experiments with silicates, which upon fusion would, like ordinary glass, be so transparent that any such cavities could at once be detected.

The fact of glass being so much more acid a silicate, and consequently, as the following analysis will show, so much more allied to granite, makes it still more adapted for this purpose by permitting of a wider margin for experimental errors; molten granite, according to Bischof, contracting more than 11 per cent in volume when brought to the glassy state or above 25 per cent when in the stony or crystalline condition.

	Plate Glass (Dumas).	Dublin Granite, Haughton.
Silica.....	73.83	73.00
Alumina.....	3.50	13.64
Lime.....	5.60	0.11
Alkalies.....	17.55	7.74
Other bases.....	traces	5.48
	99.48	99.97

If any such amount of contraction took place in the case of glass which is manufactured on so vast a scale, it certainly would not have escaped the attention of the manufacturer, nor would it be difficult to obtain trustworthy evidence on this subject. On inquiry, however, they informed me that although there was a decided contraction both in blown as well as cast glass, still that it was extremely minute, and in the case of cast glass, only just sufficient to cause the glass to detach itself from the moulds. Messrs. Chance also confirmed this, stating that they believed that no perceptible contraction takes place when glass is cast and

* In order to account for the apparent non-contraction of these, Mr. Alfred Tribe, in a letter to the CHEMICAL NEWS, vol. xvii, p. 156 (*Am. Repert.*, May, 1868, page 246), thinks that "cavities would also be found in them or on their surfaces." So far from any cavities being present which could explain the great amount of contraction which according to Bischof should take place, it was surprising to see, upon examining the many tons of castings broken up in the works, how extremely free they were from any cavities whatsoever, beyond the little so-called bubbles or air holes common to all ordinary metal castings, whilst their external surface was perfectly sharp and free from defects.

allowed to cool, and Dr. Lloyd of the Park Glass Works, at Birmingham, kindly offered to take the opportunity afforded by making a considerable number of solid large decklights for the navy weighing upwards of 40 lbs. each, to determine the amount of contraction with more precision; this, he informs me in a later communication, amounted to 1-16th inch in the length of 17 inches, equal to 1-272nd part linear, which would amount to only 14 per cent in volume.

The conclusion I would now draw from the consideration of the results obtained in this experimental inquiry, is that the amount of contraction which silicated rocks undergo in passing from the molten to the solid and cold state, must be very much less than usually taken for granted, and that in consequence of this, the effects due to such contraction, when considered in relation to certain geological phenomena, have been much over-estimated.

It now remains but to attempt an explanation of the reasons why the results obtained by me differ so very much from those made public by Professor Bischof.

In the first place, the employment of comparatively large masses cannot but greatly tend to diminish the chances of error in such experiments, Bischof's experiments having been made in crucibles. Next if we turn to the detailed account of these experiments in Leonhardt and Broon's *Jahrbuch* for 1843, pp. 1-50, it will be perceived that he melted down portions of the rocks in Hessian crucibles, the internal capacity of which was determined before and after the operation, by filling up with mercury, and by a somewhat complicated calculation the results are converted into the expression of the contraction; to any one acquainted with furnace operations and the effect of heat upon crucibles, it would probably appear most surprising that results, having any pretensions to be exact, could possibly be obtained by so crude a *modus operandi*.

NOTE ON

FRANKLAND AND ARMSTRONG'S PROCESS

FOR

ESTIMATING THE NITROGEN OF NITRATES AND NITRITES IN POTABLE WATERS.

BY SIDNEY W. RICE.

FRANKLAND and Armstrong's process for the estimation of nitrogen existing as nitrates and nitrites in potable water appears to be inapplicable when the water contains much chloride of magnesium and little carbonate of free alkali.

In such a water hydrochloric acid would be evolved by evaporation, and in consequence of the absence of any other available base, would, partially or wholly, decompose the nitrates and nitrites existing in the water. Two experiments were tried to test this. No. 1.—0.2 gramme of nitrate of potassium, containing less than a milligramme of chlorine, dissolved in water and rendered slightly acid with hydrochloric acid, after repeated solution and evaporation, yielded 0.358 gramme of residue, indicating a loss of 50.9 per cent of the total nitrogen contained in the nitrate. No. 2.—250 c. c. of water, containing an excessive amount of solid residue and nitrite, after evaporation with a very small quantity of hydrochloric acid, was found to contain a trace only of nitrite. To avoid the above source of error it is necessary, either to ascertain that each sample of water

contains a sufficient proportion of available carbonate or alkali, or else previously to make the requisite addition—say, of a weighed quantity of carbonate of sodium.

RECENT ANALYSIS

OF THE

"HOSPITAL MILD SULPHUR SPRING," OR "MAGNESIA WATER," ROYAL PUMP ROOM, HARROGATE.

BY DR. SHERIDAN MUSPRATT, M.D. (HON.), PH.D., F.R.S.E., & C.
FOUNDER AND PRINCIPAL OF THE COLLEGE OF CHEMISTRY, LIVERPOOL.

As the "Magnesia Water" has of late become so popular with the faculty, I send you the following analysis of it, deeming the publication of a fresh one necessary, owing to the changes that have occurred from time to time in the constituents of most, if not all, of the other Spas. Subjoined is the tabulated composition inferred from the new results:—

Grains in the Imperial Gallon.	
Carbonate of Lime.....	18'476
Carbonate of Magnesia.....	12'799
Carbonate of Iron.....	traces
Carbonate of Manganese.....	faint trace
Chloride of Sodium.....	215'896
Chloride of Potassium.....	27'913
Chloride of Magnesium.....	1'792
Chloride of Barium.....	1'222
Chloride of Strontium.....	trace
Chloride of Lithium.....	faint trace
Sulphide of Sodium.....	0'707
Iodide of Sodium.....	faint trace
Bromide of Sodium.....	faint trace
Ammonia.....	faint trace
Silica, &c.....	1'608

Total grains per gallon..... 280'413

Cubic Inches of Gases in the Gallon of Water.	
Carbonic Acid.....	11'50
Carbide of Hydrogen.....	5'47
Nitrogen.....	6'01
Oxygen.....	2'02
	25'00

The temperature of this spring is 44°50, and its specific gravity 1'00268; reaction, alkaline.

The water of this spring, since it was analysed by my friend and former collaborateur, Dr. Hofmann, fourteen years since (1854), has parted with its sulphate of lime, and I find replacing it chlorides of barium, strontium, and lithium. The last two were detected by the spectroscopic, in a residue I sent lately to my dear departed friend, Dr. Herapath, of Bristol, whose premature removal other comrades, like myself, must sadly deplore. The amount of some of its active ingredients (chlorides of potassium, magnesium, &c.), is increased. Its constituents admirably adapt the water for cases of dyspepsia, certain forms of rheumatism, hepatic diseases, gout, &c. Patients can imbibe it at all hours, and its diuretic properties are most efficient.

College of Chemistry, Liverpool, October, 1868.

NOTE ON SULPHUR PASTILLES.*

BY WENTWORTH LASCELLES SCOTT.

THE practice of burning sulphur for purposes of disin-

* Read at the Norwich Meeting of the British Pharmaceutical Conference.

fection has been known and valued in most countries for many centuries, it being quite common in the time of Cleopatra; but every now and then attempts are made to invest the products of its combustion with superlative curative powers, the excitement consequent thereon generally dying away at the expiration of a longer or shorter time.

As one of these "volcanic cycles," as they might be called, is now apparently just commencing in this country, I have thought that a few words upon one section of this subject might not perhaps be wholly inappropriate.

It is not unreasonable to suppose, from its very remarkable antiseptic powers, that sulphurous acid should be serviceable in the treatment of what might be popularly designated fermentive diseases and affections, as it instantly arrests oxidation in almost every form. Of late, sulphurous acid has been recommended in three different forms—as vapour mixed with that of water for inhalation, in shape of liquid spray, and lastly again in the gaseous form, as produced by burning sulphur in air.

Without expressing any opinion here of its value in a purely medical point of view, my present object is simply to direct attention to the danger incurred in the use of the ordinary pastilles as commonly sold for disinfection.

I have examined a very large number of these, in this country and in Scotland, and find that, with few exceptions, they are made by simply "casting" sulphur into suitable moulds, the fluid element being mixed with a little finely divided charcoal, or black lead in some instances. They do not burn evenly, retaining their form, like the aromatic pastilles; but speedily fuse, and become little pools, as it were, of "liquid fire," difficult to extinguish, and extremely liable to inflame surrounding objects. As a rule, these "disinfecting pastilles" are placed in the hands of some servant, who simply applies a match to their point, and leaves them to "burn out;" thus, I hear from a correspondence with several insurance offices, have many "accidental fires" originated during the last few years, to the endangerment of life and property.

I have lately suggested a preferable mode of manufacture, which is now being very largely adopted, several hundredweights per month of these pastilles being made at this time.

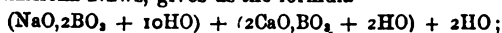
Pure sulphur is reduced to a state of minute division, and intimately mixed with about 20 per cent of fresh dry plaster of Paris, some charcoal, and a mere trace of nitre; when mixed, a little stiff flour-paste is added, and the whole brought to a dough-like consistency under powerful stones. This dough, being formed in the requisite moulds into "pastilles," the latter are finally dried by steam-heat. Such pastilles burn slowly and evenly, not liquefying, and can be readily extinguished if required.

ON SOME BORACIC ACID MINERALS OF PERU.

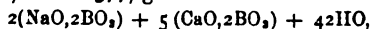
BY J. WALKER, PISAGUA, PERU.

UNDER the names of tinkalzit, boracite, boronatrocalcite, borate of lime, and tiza, you have at various times published contributions describing the Peruvian mineral known in commerce as borate of lime. Some of your contributors hold opinions at variance as to the chemical constitution of this mineral, and seem to delight in racking their brains to construct a formula that will agree with their particular analysis.

For example Dr. T. L. Phipson, in No. 96 of the *CHEMICAL NEWS*, gives us the formula—



G. Lunge, in No. 377, gives—



and in the same paper he informs us that Dr. Krant's formula is—



and that of Rammelsberg—



In No. 385 (*Eng. Ed.*) Professor How supports the formula of Dr. Krant.

Being on the spot where this so-called borate of lime is collected, I took the opportunity of selecting seven distinct specimens, and subjected them to analysis with the following results:—

	1	2	3	4	5	6	7
Boracic Acid.....	41'30	41'50	31'42	24'93	39'25	8'42	30'87
Silicic Acid.....	—	—	—	2'40	—	—	—
Lime.....	7'40	12'90	11'33	13'76	13'76	2'46	9'90
Soda.....	11'90	4'50	4'90	—	2'64	1'20	5'18
Chloride of Sodium.....	0'70	0'70	1'40	0'95	3'15	37'10	0'45
Sulphate of Soda.....	0'50	4'10	2'15	11'13	7'30	26'12	0'60
Sulphate of Lime.....	—	—	—	14'37	—	—	—
Sand and Insoluble.....	0'60	1'50	19'70	3'80	3'70	16'90	26'80
Water.....	37'60	34'80	29'10	29'50	30'20	7'80	26'20
	100'00	100'00	100'00	100'00	100'00	100'00	100'00

I will not attempt to construct a formula from any of those analyses, but will simply suggest a possible explanation of the differences in composition. Spread over the same pampa where the borate occurs are numerous deposits of chloride of calcium and sulphate of lime. Even under a tropical sun where it never rains, those deposits retain sufficient moisture to keep them quite soft, like half-dried mud. In passing over such interesting ground, which extends in some places for miles, the mule on which I rode sank often up to the knees in this well-known deliquescent salt. Now suppose a mixture of solutions of chloride of calcium with biborate of soda, or other compound of boracic acid and soda, to take place, the composition of the resulting deposit would of course depend upon the proportions in which such solutions were mixed.

The seven specimens which I have collected and examined represent so many distinct deposits, occurring in different basins. There is every probability that the formation of the mineral is due to precipitation, the after shrinking of such a gelatinous precipitate accounting for the nodular form in which it is found. It would be very easy to select specimens with composition varying from almost pure biborate of soda to that having none of this substance at all, such as is shown in analysis No 4, which has evidently been formed from sulphate of lime and an indefinite compound of soda with boracic acid, only a small part of the resulting sulphate of soda having drained off. The richest specimens are probably formed from chloride of calcium and a sodio-boracic salt, the resulting chloride of sodium, owing to its solubility at ordinary temperatures, draining off more readily than sulphate of soda under the same circumstances.

I am induced to send you these analyses and remarks, in the hope that they may be interesting, not only to your formula-constructing friends, but to your readers in general.

To chemical manufacturers in England, who use this substance for the manufacture of borax by boiling in a solution of carbonate of soda, it would be very important for them to avoid such descriptions as is represented

by analysis No. 4, the large proportion of sulphate of lime not only rendering an equivalent proportion of carbonate of soda now effectual, but introducing so much sulphate of soda in solution with borax as to cause more manipulation with the production of an inferior article.

Piragua, Peru, August, 31, 1868.

FLUX FOR BLOWPIPE ANALYSIS.

MR. STEPHEN D. POOLE has communicated the following note to the *Scientific American*.—Among the various methods of testing the presence of substances in chemical examinations, that by means of coloured flames seems to be of growing importance, not alone with reference to the application of the spectroscope, but in the ordinary use of the blowpipe or gas flame. For unmasking lithia, &c., the books prescribe a mixture of bi-sulphate of potash and fluor spar; but this flux is objectionable, on account of the intense violent tint (potash) which may disguise the reaction due to the presence of small quantities of other substances. Fresenius directs that silicates be mixed with sulphate of lime; but this salt is, by itself, infusible, and its power of decomposing the natural silicates small. On the other hand, a mixture of sulphate of lime and fluor spar, in equivalent proportions (say about two parts of crystallised selenite to one of fluor spar finely mixed), forms an easily fusible bead, which by itself gives only a very faint dull red tint (lime) to the flame, but which renders the presence of such elements as give colour most beautifully evident and characteristic.

Thus, small portions of lepidolite, petalite, &c., mixed with this flux, impart the fine carmine tint; copper, strontium, their well-known colours, especially after continued blowing. Potash and soda minerals (felspar and albite) are at once distinguished.

Presuming that many of your readers are interested in Determinative Mineralogy, I invite them to make use of the above-named reagent, and if possible extend its utility.

ON SPECIFIC GRAVITY OF TINCTURES.*

BY W. LAIRD, PH. C.

In the P. B., in common with other pharmacopœias, after the formula for the preparation of a good many of the acids, liquors, and solutions, we have a note of the "characters and tests" of the various products. On looking over the P. B. it occurred to me that it was a pity that the compilers had not carried out the same rule in the section for tinctures. In two cases only is there any mention made of the characters the product is expected to possess,—Tinct. Opii and Tinct. Ferri Perchloridi. It is surely of as much importance for us to know the sp. gr. of any of the other tinctures as of Tinct. Ferri. Why tell us that sp. gr. of Syrupus is 1'330 and say nothing of that of Tinct. Opii; or why tell us that Syr. Rhamni is 1'32 and say nothing of Syr. Rhei, Scillæ, or Zingib? If useful in the one case it would be in the other. Being strongly impressed with this idea, I would suggest that the members of this Conference might aid in completing this portion of the P. B. by recording the sp. gr., and also any peculiarity of tinctures as prepared by them, and forwarding their notes to the meeting. Some may be inclined to think

* Read at the Norwich Meeting of the British Pharmaceutical Conference.

this use: s trouble, but I have a case in point, showing a knowledge of the sp. gr. of a tincture to have been useful in at least one instance in the detection of unfair trading.

Some time ago I was told of a person who was selling tincture of ginger for 2s. per 16 fluid ounces. I at once said it could not be good, but was assured that it was so. I procured some of the tincture in question, and found its sp. gr. to be .898 instead of .840, as I had previously found it to be when made according to the P. B. On separating the spirit I found it to be .895, or 26 per cent. instead of fifty, showing that this tincture was made with a spirit 16 overproof instead of that required by the P. B. The money-value of the spirit would be about 15s. 7d. instead of 22s.

The present duty on 60 per cent is 16s. 6d.
" " 16 " 11s. 7½d.

Loss to Revenue.....4s. 4½d. on

every gallon of this tincture sold. This portion of the question we may, I presume, leave to the excise; and we will rest content if our bringing this under notice result in ultimately establishing an approximate standard of sp. gr. for all tinctures. I subjoin that of those I have myself kept note of:—

Tinct. Benzoin Co.....	.898
" Camph. Co.....	.927
" Cardam. Co.....	.955
" Catechu.....	.960
" Lupuli.....	.930
" Myrrhas.....	.845
" Opil.....	.940
average of three makings. }	
" Zingiber.....	.840

While on this subject may I be allowed to ask what should be the sp. gr. of Decoct. Sarsæ Co.—1 to 7? I have two samples purporting to be of same strength; one is 1.105, while the other is only 1.041

OBSERVATIONS ON EXTRACTUM CARNIS. (LIEBIG).*

BY THOS. T. P. BRUCE WARREN.

If an aqueous solution of extractum carnis be digested with a large quantity of rectified ether, there is found on the surface of the solution, after a short time, a substance which does not dissolve in the supernatant ether, and if mixed mechanically, by agitation, with the solution, again separates, occupying the same position as before.

I was led to this observation on examining extractum carnis for fatty and gelatinous matters about four years ago, during which time the contents of the bottle have remained undisturbed. I convinced myself at the time of its not being either of a gelatinous or fatty character; and not being at the time acquainted with a substance of such an apparently intermediate relation, I thought it would be interesting to determine at a future time the properties which this substance possesses as compared with the already examined principles existing in extractum carnis, and to compare it with the proximate principles existing in animal tissues, and which are possible to exist in extractum carnis.

The ether was first carefully decanted, and the solu-

tion separated by filtration, the substance remaining on the filter was thoroughly washed with boiling water.

On the surface of the solution it appeared as a jelly-like stratum, with a large quantity of air bubbles invariably adhering to it, and which were removed only by drying.

It possesses in an eminent degree the smell peculiar to the extract, and is decomposed by heat without melting. It is not dissolved by boiling water.

In dilute acetic acid, the caustic alkalies, and alcohol it is partially soluble. Its alkaline combinations yielded no crystals.

These results, and notably that of its swelling in water without dissolving, and its insolubility in ether, show that it consists principally of cerebrie acid, derived probably from the nerves which ramify the parts from which the extract is made.

A suggestion arises, that cerebrie acid, as transversed through the nerves of the muscles, may have a distinct modification to that found in the brain, for its insolubility in water should prevent its appearing in the extract even in the smallest quantity.

PURIFICATION OF TIN ORES FROM WOLFRAM.

Owing to its great specific gravity, and its undecomposability, wolfram cannot be separated from tin ore by mechanical dressing, by roasting, or by treatment with acids. If present in larger quantity it alloys the tin and renders it difficult to fuse. In Cornwall, wolfram is separated by Oxland's smelting method, which may be carried out with two modifications; namely, by employing carbonate of soda, or sulphate of soda, both for the purpose of forming soluble tungstate of soda.

At East Pool mine this process is carried on in reverberatory furnaces, furnished with an iron pan instead of a hearth, and so constructed that the flame from the grate passes first over the fire-bridge along the surface of the pan, then across a bridge which lies opposite the fire-bridge, and through flues under the bottom of the pan, into a channel leading into a chimney.

The use of the cast-iron bed effects considerable economy of fuel, and it is admirably adapted for the calcination of raw ores, and the evolution of sulphur and arsenic contained in them, but it is especially useful instead of fire-bricks or tile by preventing the loss which would result from the reaction of the soda ash on the silica of the brick, giving rise to the formation of double silicate of soda and tin.

According to the fineness of the schlich, charges of from 6 to 9 cwts. of ore are made (the finer the ore the lighter the charges), and from 9 to 12 lbs. of carbonate of soda (containing 48 per cent of alkali) per cwt. of ore, are spread over the heated ore; one or two shovelfuls of coal are thrown upon that part of the hearth opposite the fire-bridge, in order to obtain a temperature as uniform as possible. The mass is kept at a white heat for about six hours; it is stirred every quarter of an hour, and every half hour some coal is thrown upon the back of the hearth. Half the charge is now removed from the furnace, then, after one more stirring, the other half. About 1½ tons of ore, with 330 lbs. of carbonate of soda, are treated in four charges, yielding in 24 hours about 10 cwts. of pure tin ore. The mass, when heated in a pasty state, and after cooling being frothy, is broken in pieces the size of an egg, mixed with 25 per cent of quartz, and pounded under a stamping mill, the quartz serving to separate the har-

* Read at the Norwich Meeting of the British Pharmaceutical Conference.

alkali crust from the tin ore. The pounded mass is repeatedly washed, the coarser part pounded two or three times with quartz, and sometimes again treated with soda in the reverberatory furnace. This preparation is comparatively expensive, and it causes a considerable loss of tin ore both mechanically and chemically; the chemical loss arises from the formation of soluble stannate of soda.

When sulphate of soda is used instead of carbonate of soda, the loss of tin is lessened and the process cheapened, but it is rendered more difficult as the reaction must be alternately oxidating and reducing. The dressed ore is mixed with sulphate of soda, according to the amount of tungsten in it, so that approximately tungstate of soda may be formed; some pulverised coal is added, and the mixture heated in a reverberatory furnace by a smoky reducing flame, whilst the mass is continually raked; the sulphuric acid of the sulphate of soda decomposes, and the liberated soda combines with tungstic acid when treated by an oxidating flame. The red-hot mass is removed from the furnace and thrown into a cistern full of water, after about six hours, and when the colour and other qualities of the roasting mass indicate its decomposition. After 24 hours the solution of the tungstate is caused to run off through a sieve attached to one of the sides of the cistern; the remaining tin stone is then washed again to remove the peroxide of iron mixed with it, which originated from the tungsten. Four charges equal to 36 cwt. of schlich are treated in 24 hours, consuming 4 or 5 tons of coal.

The whole of the solution of tungstate of soda is sometimes boiled down, and the crystallised salt used for dyeing purposes, for rendering fabrics non-inflammable, also for bleaching linen, for the production of bronze colours, &c.

At Zinnwald, in Bohemia, wolfram is separated mechanically, and sold at about 10s 6d. per cwt. In 1859, 25½ tons were produced; in 1860, only 5 tons.

At Schlaggenwald (Preuss. Zeitschr., 1862, Bd. x., Leif. 3, p. 165), 4 or 5 cwt. of ore, with an admixture of common salt, are roasted in a reverberatory furnace for eight hours, at a consumption of 25 cubic feet of coal. The chloride of copper and tungstate of soda thus formed are lixiviated with water, and the copper in the lixivium is precipitated by iron, and tungstate of lime by means of chloride of calcium; the lixiviated ore is washed again.

ON THE BALLAGAN SERIES OF ROCKS.*

BY J. WALLACE YOUNG.

In a former paper read before the Society,† I pointed out the general composition of some rocks known as the "Ballagan Limestones;" since then, however, I have made a more minute investigation of the rocks of the series, more particularly as they are developed in Ballagan Glen.

In the fine section there exposed, there are, I understand, upwards of 230 alternating beds of dolomitic limestones, sandstones, and shales. The limestones vary in thickness from 1½ inches to about 1 foot. They partake somewhat of a nodular character, and are quite amorphous in structure; the colour is usually grey, but some layers have a more or less red tinge. Some of these are very hard, others again break easily into splintery fragments.

The shale beds parting the limestones are sometimes not over 1½ inches thick, but more frequently from 1 to 2 feet; they vary from a sandy shale to a fine clay shale, and all more or less effervesce with hydrochloric acid. The following analysis may serve to give some idea of their composition:—

Dried at 100° C.	
Sand and Clay.....	77.61 per cent.
Soluble Silicic Acid.....	2.73 "
Lime.....	2.15 "
Magnesia.....	1.59 "
Oxide of Iron and Alumina	8.37 "
Carbonic Acid.....	1.64 "
Water and Loss.....	5.91 "
100.00 "	

The sandstones are impure, consisting of quartz grains cemented with felspathic matter; treated with hydrochloric acid, a mere trace of carbonic acid was given off. The sandstones and sandy shales contain abundance of small fragments of mica.

Horizontal layers of white fibrous gypsum are common, and a red granular variety is found generally at right angles to the other; this last being of more recent date than the white, which from its position must have been formed at, or shortly after, the deposition of the shale beds.

Eight specimens of the limestone were taken from different beds, proceeding from the lowest to the very highest of the series, in order to determine the relative quantities of lime and magnesia. The following table gives the result of the analysis:

Dried at 100° C.									
Insoluble...	18.12	22.40	18.40	21.60	13.59	20.50	20.55	23.25	
Lime.....	24.16	23.35	23.80	23.50	26.99	24.25	24.10	23.00	
Magnesia...	16.35	14.15	17.20	14.25	17.21	15.00	15.15	15.10	

No. 1 was from the lowest exposed bed; colour, reddish. Nos. 2, 3, 4, 5, 6, 7, and 8 beds in ascending order; colour, grey. It must be understood that these specimens were taken from every eighth or tenth alternate layer of limestone, and represent the whole vertical height of the exposed strata. A full analysis was made of the specimen marked No. 5, in order to give some idea of the general proportion of the other ingredients.

No. 5.—Dried at 100° C.	
Clay and Sand.....	11.92 per cent.
Insoluble matter	
Silicic Acid.....	1.67 "
Lime.....	26.99 "
Magnesia.....	17.21 "
Protoxide of Iron.....	0.64 "
Oxides of Iron and Alumina..	2.67 "
Carbonic Acid.....	38.00 "
Loss, &c.....	0.90 "
100.00 "	

In this analysis it will be observed that the carbonic acid is less than is required for the formation of the normal carbonates of lime and magnesia; some part of either, or both, must therefore have been combined with the silicic acid. The insoluble matter when fused with alkaline carbonate, and tested in the usual manner, was found to consist of silicic acid and alumina (or clay), and only very small quantities of lime and magnesia. Notwithstanding the presence of so much gypsum in the series, I could not detect anything but the merest traces of sulphuric acid in any of the specimens examined. However, in Auchenreoch Glen, near Dum-

* Transactions of the Geological Society of Glasgow.

† Vol. xxxiv., p. 64, "On the Presence of Magnesia in Rocks."

barton, where this same formation occurs, the limestones were found to contain no inconsiderable quantity of sulphuric acid, and fissures are often found filled with radiating crystals of gypsum.

I had intended examining in a similar manner some of the dolomitic limestones from the other localities where this formation is exposed, but I have been only able as yet partially to examine two varieties from the beds situated in the hills above Greenock. The strata are there inclined at a pretty high angle, but have a similar appearance to those in Ballagan Glen. I could not find here any gypsum, but there are abundant layers of white fibrous carbonate of lime, and which presents the same aspect, and occupies a similar position to the gypsum in Ballagan Glen.

The following table exhibits the proportions of insoluble, lime, and magnesia, in the two beds:—

	I.	II.
Insoluble.....	8.35	5.7
Lime.....	28.65	29.55
Magnesia.....	18.25	19.25

These specimens are much purer than the others, and it would be interesting to find out what relative position they occupy, with regard to the strata in Ballagan Glen, seeing they are so far apart.

I do not think that we can explain the formation of these beds upon the supposition that they were originally limestone, and subsequently converted into dolomite. From their somewhat nodular structure, and impure character, it appears as if they had rather proceeded from the segregation of a dolomitic mud, so to speak. At all events it is quite evident that the conversion—if such was required—must have taken place at, and not subsequent to, their deposition. The presence of gypsum in the series does not support the idea that the magnesia may have originally existed as sulphate, the relative amount being so small.

DESCRIPTION OF AN
AUTOMATIC ARRANGEMENT
FOR
CONTINUOUS FILTRATION AND WASHING
PRECIPITATES.

BY HENRY B. BRADY.

[A WORKING model of the apparatus was exhibited at the Norwich meeting of the British Pharmaceutical Conference, and an extempore description was given, of which the following is a summary. As the arrangement requires modification for the two distinct operations for which it is designed, it will be necessary to give a separate description of the two forms. Woodcuts 1 and 2 illustrate the subject.]

The arrangement for continuous filtration is exceedingly simple. The object is to keep a filter constantly filled up to a certain height. The rigid stand, *a, a, a, a*, consisting of two horizontal boards connected by two uprights, may be replaced by any convenient laboratory fittings, its object being to carry a funnel-holder, *b*, which swings freely on a pivot, *d*. One arm holds the funnel, the other is balanced by a suitable weight, *c*. A vulcanised india-rubber tube, *e, e*, and a wire stirrup, *f*, are the only other essential portions of the arrangement. The stirrup encircles the flexible pipe, and, passing through the upper board, is connected with the arm which holds the funnel. A wire rack, *g*, is added

as a convenient means of regulating the pressure of the stirrup.

Continuous Filtration (FIG. 1).



It is obvious that if the counterpoise on the centre board is adjusted so that the weight of the filter when filled to the height desired will turn the scale, the pressure of the stirrup on the india-rubber tube will immediately cut off the supply. In practice it is found that the supply very soon adjusts itself exactly to the rate of filtration, and then the funnel remains stationary. The fluid may be supplied in many ways; a common washing-bottle answers very well, or a tap-jar may be employed, or any other similarly convenient appliance. The drawing shows a somewhat more complicated arrangement, in which the supply is brought from an open beaker by means of a syphon, in which case the suction-pipe must be kept closed by a pinch-cock.

Washing Precipitates (FIG. 2).



Object, to provide an intermittent supply of fluid in such a way that the filter shall empty itself completely before it is filled again. The same rigid stand, and the same oscillating funnel-board are used, but there is superadded another board like *b*, suspended in the same manner a little above it, as seen at *k*. This intermediate member holds a funnel, *i*, fitted with a Tantalus syphon, immediately above the funnel used for filtering, and has a wire and stirrup, *k*, working from the opposite end. Both stirrups being raised to commence the operation, the upper funnel is filled as high as the top of the Tantalus syphon, and therefore discharges itself into the filter. The filter, then, with the weight thrown upon it, turns the scale and cuts off the supply, just as in the simpler apparatus. It will be seen that if the stirrup, *k*, completely closed the elastic tube on the emptying of the upper funnel the operation would come to a standstill after the first delivery; and to avoid this a small screw, *l*, is introduced to prevent the weighted end of the board swinging back to its full extent, so that when the filter is emptied and opens the tube at *f*, a slow stream commences to pour into the funnel *i*, increasing in rapidity as the augmented weight raises the wire at *k*.

It is scarcely necessary to explain the principle of the Tantalus syphon—a contrivance familiar to many as the basis of a philosophical toy. It consists of a bent tube like a U, with one arm longer than the other. The longer arm is fitted into the tube of a funnel by means of an india-rubber washer. Its syphon action is brought into play directly the fluid in the funnel has risen above the level of the top of the bend, and it then draws off the contents as far as its shorter arm reaches. The figures will explain the rest.

The application of the principle to the large filters used for manufacturing purposes will naturally suggest itself, and though the model exhibited was made for analytical purposes on a small scale, there is no reason that modifications to suit any variety of circumstances should not be introduced.

The simpler form of apparatus is in regular use in one or two laboratories for filtering solutions. A multitude of cases occur to the pharmacist in which it is desirable that his filter should never run too low, as in the separation of essential oils from distilled waters, and in such as these its employment would be of great advantage.

The arrangement was designed by Mr. W. Rennoldson, of Newcastle, and the model shown was lent by Mr. A. Freire-Marreco, Reader in Chemistry in Durham University, who has since presented it to the Museum of the Pharmaceutical Society at Bloomsbury Square.—*Pharmaceutical Journal*.

FOREIGN SCIENCE.

PARIS, OCT. 21ST, 1868.

Employment of Vegetable Tar in Dyeing—New Process for Generating Chlorine.—A Thallium Detonating Mixture—Manufacture of Permanganate of Potash.—Pulverized Coke in Piles of great Resistance.

M. LEFORT has published a note on the employment of vegetable tar in dyeing. In the year 1851, M. Pettenkoffer observed that wood vinegar exposed to the action of ammonia and of perchloride of iron, became coloured a deep violet. M. Pauli, his assistant, endeavoured to isolate the substance which caused this reaction, and obtained, by treating the acetic acid from wood with sulphuric ether, an acid crystal-

lizing in fine needles, very soluble in water, alcohol, and ether, presenting the characters of pyrogallol acid; subsequent examination, however, proved this body to be pyrocatechuic acid. The circumstances under which oxyphenic acid is produced, and the very deep colouration acquired by tar water upon the addition of a salt of sesquioxide of iron, led M. Lefort to think that vegetable tar might be useful in dyeing textile matters. Experiments in this direction have left no doubt as to its applicability. According to analyses made, vegetable tar contains on an average about 1 per cent of oxyphenic acid, and as this acid is very soluble in water, the more concentrated the solution, the more coloured the dye bath. Upon the addition of perchloride of iron, the tar water is immediately coloured a dirty green, which is changed to a violet tint by the addition of potash or ammonia; but, with or without the addition of alkali, the oxyphenate of iron formed under these circumstances fixes itself upon animal and vegetable fibres, to which it communicates an ash-grey colour of great solidity. To dye textile matters with oxyphenate of iron, the following is the method of operating:—The fibres are steeped in a solution of perchloride of iron for several hours, and, when sufficiently drained, transferred to a vessel of filtered tar water, containing one of vegetable tar to ten of water, heated to 60° or 80°. After several hours' maceration, they are withdrawn, washed with water, and afterwards with soap to remove the aromatic and resinous principles. Soap does not act upon the colouring principle which is fixed upon the fibres, and the resulting impression presents all the solidity common to pigments having iron for the basis.

A Belgian chemist has devised a new process for generating chlorine. He first forms trisulphate of sesquioxide of iron, by the direct combination of this oxide with sulphuric acid, and then mixes the trisulphate obtained with 3 equivalents of chloride of sodium or other convenient chloride. Upon heating the mixture in dry air, the chloride of sodium yields all its chlorine.

M. Boettger has formed a mixture which inflames by friction, of 8 parts of teroxide of thallium and 1 part of protosulphide of antimony.

Some facts worthy of attention, concerning the manufacture of permanganate of potash, have been pointed out by M. Stædeler. In the preparation of this salt by heating a dilute solution of the manganate, a third of the manganic acid is reduced to the state of peroxide without taking part in the reaction; the case is the same when hydrochloric acid is used to effect the transformation, notwithstanding that this process permits of the use of concentrated solutions. Things happen differently when chlorine is employed. The following is a convenient method of operating:—The crude pulverised manganate is abandoned in its own weight of water for several days, then a similar quantity of water is added, and a current of chlorine transmitted until the liquid becomes red; the solution is frequently agitated, diluted with four times its volume of water, filtered through coarsely powdered glass, and reduced to one-fifth of its original volume. At this point the permanganate crystallises; it can be obtained in a state of purity by recrystallizations. The yield is 50 per cent of the weight of peroxide of manganese employed.

A note entitled "On the Part Played by Pulverised Coke in Piles of Great Interior Resistance," by M. Gaiffe, was communicated at a recent meeting of the Academy. In examining the action of the pounded coke which is placed round the carbon in the piles of M. Leclanché, M. Gaiffe has been led to conclude that this addition considerably augments the surface of the carbon element, and extends this surface to within a very minute distance of the porous vessel; it is probable that the employment of coke powder would give good results in all piles of great interior resistance. The experiment was made with two batteries, the one sulphate of lead, the other sulphate of protoxide of mercury. Their interior resistance was much diminished, and their constancy became nearly perfect. The deviation

of a galvanometer with thick wire and not very sensitive, in permanent communication with the mercury battery, only varied one degree in four and twenty hours; it was 28° at the moment of closing the circuit, it was still 27° twenty-four hours later.

REPORTS OF SOCIETIES.

PHARMACEUTICAL SOCIETY.

THE opening meeting of the session was held on Wednesday evening, October 7th, under the presidency of G. W. Sandford, Esq. There was a very large attendance, and, for the first time, the meeting was honoured with the presence of a goodly number of ladies. We hope the council will in future invite ladies to their *conversazione* as well as to their opening meetings, for their presence always lends a charm to the proceedings, and has, we are sure, an influence for good on the students.

At no period of the history of this society has there been more cause for congratulation than the present. For twenty-eight years the council have laboured hard to promote the interests of pharmacy, and to render examination compulsory on those who shall carry on the business of a chemist and druggist. The attainment of this object by the Pharmacy Bill which passed both Houses of Parliament during the last session was, of course, a cause for rejoicing at this the first meeting of the society since the passing of the Act.

The PRESIDENT called upon the professors to announce the results of their respective examinations at the close of the last session, and it was highly gratifying to hear them speak in such high terms of the conduct of the students. Whether in the lecture theatre, the botanical gardens, or the laboratory, they had not only conducted themselves well and gained the praise of those who had had an opportunity of watching their behaviour and comparing it with students at other schools, but they also went through their studies with real earnestness, determined to make the best use of their time, and to gain as much knowledge as they could. With regard to the prizes, medals, and certificates, they were never better merited than during the last session. The President then distributed the prizes, and called upon Mr. H. B. Brady, of Newcastle, to deliver an inaugural address. We congratulate the council on their choice of one so peculiarly fitted to open the session at such an important time as the present. The address is quite as applicable to students in our schools of chemistry as to pharmaceutical students, and we trust our short report may lead some to enter into their studies with renewed energy, bent upon searching into the mysteries of that branch of science to which they are giving their special attention.

MR. BRADY began by making a few observations on the present aspect of pharmacy in its social and ethical relations; they were no longer a mere voluntary association as they had been stigmatized in the House of Commons during the late debate, but now occupied the same relation to Government as other professional bodies who hold examining powers, the Legislature having, with general approval, given them, as a body, a certain monopoly on an educational basis, as it had done heretofore to lawyers, surgeons, and others; they had, however, with their new powers and improved position, new and increased responsibilities. Those who had given them new powers looked for an advantage in having a specially educated body of men to perform certain duties, and it was for them to qualify themselves for the enlarged sphere opened to them. No mere curriculum of college instruction could impart that sort of intellectual cultivation and tone of thought that places a man above the category of tradesmen, but they must qualify themselves by closer mental training for that higher social position which it would be their own fault if they

did not occupy. In speaking of systematic study, Mr. Brady said it was in after life that the man who had done his elementary work well, systematically reaped its full advantage; for he had ready a framework more or less elaborate in which each new truth finds a natural place. The amount of detail a student could impart to his work was, no doubt, partly dependent on the opportunities at his disposal and the bent of his mental powers, but its accuracy and usefulness depend on conditions entirely within his own command, and the first in importance was system, or regularity in the attendance of lectures, demonstrations, and laboratory practice. Each step in scientific knowledge is dependent upon the one that precedes it, and bears an equally close relation to that which follows. To miss a single lecture in a course consisting of a hundred seemed a trifling matter, but the real loss could not be measured by mere numerical proportion. It might easily happen that an acquaintance with a principle expounded in the neglected discourse is essential to the proper comprehension of many that follow. A German author, Richter, speaking of this sort of steady persistence in following out a well-devised course of education, concluded a paragraph by saying that—"Regularity is unity, unity is God-like; only the Devil is changeable."

The speaker then impressed upon the students the necessity of being *thorough*, not to be content with surface work, not to accept the appearance for the reality, the gilt for the gold. In learning a principle, they must strive to know the phenomena from which it has been deduced; in the acquirement of facts, they must seek to associate them with the laws by which they are explained. It could not be too often repeated that there is no royal road to knowledge; and the many tempting bye-ways that diverge from the straight course—green, sunny, and seductive—that promise to lead to the same goal, soon show, though winding and deceptive, and not easily traced, that to whatever end they do lead it is not the one desired. You may know them only by one fact—they always tend, just a little, downwards. The right road is up-hill—rough near its outset, and marred by obstacles that at a little distance look formidable. These are surmounted by toil and perseverance, but the achievement brings new spirit into the work, the bye-ways lose their fascination, and new difficulties are sought rather than avoided. The condition in which the drudgery of the onset becomes a labour of love is attainable by all; and until it is attained scientific progress is hard and uncertain. Mr. Brady then gave some useful advice on recreation, cultivating a taste for literature and general science, &c., and closed a most instructive and practical address by referring to the history of William Allen, F.R.S., the first president of the Pharmaceutical Society, whose youth gave him no special advantages, but who had to *work his way* to succeeding positions of increased responsibilities in that well-known pharmacy at Plough-court with which his name is inseparably connected, and who, by diligence, devotion, and earnestness, became the man of science whose memoirs on carbon, on carbonic acid, and on respiration, were amongst the finest researches of their day—who became the friend and associate of Davy, Wollaston, Berzelius, De Luc, and others of that noble fraternity of chemists and physicists,—the brilliant and fascinating lecturer on chemistry at Guy's Hospital and the Royal Institution,—and the philanthropist labouring hand in hand with Clarkson, Brougham, Wilberforce, and the rest of that devoted band, to whom civilisation owes the suppression of the slave trade, the amelioration of a barbarous penal code, and the initiatory steps in the spread of education.

ACADEMY OF SCIENCES.

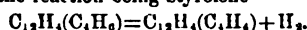
PARIS, OCT. 14TH, 1868.

Hydrides of Hydrocarbons (Styrolenic series).—Volumetric

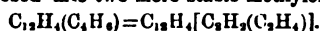
Determination of Zinc.—Chlorosulphuric Ether.—Action of Zinc Ethyl on Bichlorinated Acetal.—Bichlorinated Aldehyde.—Colouration of Peroxide of Nitrogen.

FRENCH chemists' minds have been so fertile lately that my communications for some time will be little more than abstracts of the *Comptes Rendus*. The following memoirs were brought forward on the 10th of August:—"Determination of the Number and the Laws of the Variation of Coefficients of Elasticity for Solid Heterogeneous Bodies," by M. Gosiewski; "On the Hydrides of Hydrocarbons (Styrolenic series)," by M. Berthelot; "Coloured Reactions of Aniline, of Pseudo-toluidine, and of Toluidine," by M. Rosenstiehl; "On the State of Salts in Solutions," by M. Mchay.

M. Berthelot commences his memoir with the analytical proof that ethylbenzol is hydride of styrolene, in confirmation of the results already obtained by synthesis. Action of heat on ethylbenzol. The vapour of this compound made to pass through a porcelain tube heated to moderate redness is nearly totally decomposed; the most abundant product of the reaction being styrolene—



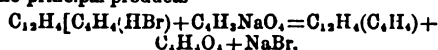
Its formation in great quantity is characteristic of ethylbenzol, and distinguishes this from xylene or dimethylbenzol, the isomeric hydrocarbon. Although in smaller proportion, benzol is formed simultaneously with styrolene— $C_{12}H_{14}(C_2H_5) = C_{12}H_6 + C_2H_2$. These are the most abundant, and to some extent the normal products of the decomposition of ethylbenzol; but, as the most organic reactions, secondary products are formed. Among the secondary products is toluene, or methylbenzol— $C_{11}H_{10}$, or $C_{12}H_8(C_2H_4)$. The proportion of this body formed in M. Berthelot's experiments amounted to about one-third that of the styrolene. Naphthalene, $C_{10}H_8$, and hydride of naphthalene, $C_{10}H_6$, were also detected. The action of a red heat transforms then a small portion of ethylbenzol into dimethylbenzol by a sort of molecular transposition, which results from the metamorphosis of an ethylenic residue decomposed into two more stable methylenic residues,



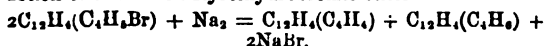
The formation of styrolene by the humid method is effected by aid of the ether, which is prepared by reacting upon boiling ethylbenzol with bromine vapour. To transform this ether into styrolene, it is only necessary to remove the elements of the hydrobromic acid—



When the ether is made to act at 180° upon alkaline acetates or benzoates, a small quantity of styrolene (also meta-styrolene) is formed, while styrolacetic and benzoic ethers are the principal products—



This secondary reaction which furnishes the hydrocarbon, M. Berthelot remarks, he has observed for a long time, is produced upon nearly all hydrochloric and hydrobromic ethers of true alcohols. Styrolene appears again as a secondary product, and together with ethylbenzol, in the reaction of sodium on styrolhydrobromic ether—



But it is the reaction of an aqueous solution of potash upon this ether at 180° which furnishes the largest amount of styrolene. In this reaction the hydrocarbon is changed first, under the influence of heat and the alkali, into meta-styrolene. In distilling the hydrocarbon produced, one obtains above 300° a mixture of styrolene regenerated from its polymer, and an oxygenated body (probably styrolenic ether; $C_{12}H_{14}O_2$). By redistillation, styrolene with all its characters is obtained.

On the 17th of August, M. Nicklès communicated a memoir "On Manganoso-Manganic Fluoride"; M. Renard,

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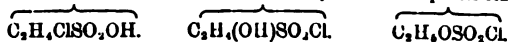
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a memoir "On the Volumetric Determination of Zinc." The following were also brought forward at this meeting:—"On Chlorosulphuric Ether," by M. de Purgold; "On the Condensed Ureas," by M. Schiff (second memoir); "Action of Zinc-Ethyl on Bichlorinated Acetal," by M. Paterno; "On Bichlorinated Aldehyd," by M. Paterno.

M. Renard's volumetric process of determining zinc depends upon the following reactions:—When in a determinate quantity of a solution of yellow prussiate of potash the solution of a zinc salt is added, the whole of the zinc is precipitated as double ferrocyanide of zinc and iron, completely insoluble in ammoniacal water. By determining with the aid of permanganate of potash the excess of prussiate of potash employed, the amount of zinc is obtained by calculation. To assay a mineral, one or two grammes are dissolved in aqua regia, ammonia added, the solution filtered from the precipitate, and the latter washed. To the filtered part, 25 c.c. of a solution of ferrocyanide of potassium (150 grammes to the litre) are added; the solution is made up to 250 c.c., filtered, 100 c.c. of the filtrate are measured into a glass vessel, and neutralised with pure hydrochloric acid free from chlorine and sulphurous acid. Afterwards the solution is rendered strongly acid with about 30 c.c. of this same acid, and titrated permanganate solution added until the whole of the yellow prussiate is transformed into red prussiate. By calculation the amount of zinc contained in the mineral is arrived at. None of the metals commonly present in minerals, such as iron, alumina, manganese, lead, &c., influence the process. Either they are precipitated by the ammonia, or in the case of others—lead, for instance, the oxide of which is soluble—they are not precipitated by ferrocyanide of potassium. Copper is an exception.

When chloric ether is brought in contact with anhydrous sulphuric acid at zero, this solid gradually liquefies. Heating to 100° causes the mixture to become brown and disengage sulphurous acid; but when it is poured drop by drop into water at zero, a heavy stratum of oil is formed, which, washed and dried upon chloride of calcium, is already deprived of the unchanged sulphuric acid and chloric ether. This oil is decomposed by distillation at the ordinary pressure, a little above 100° . In the vacuum it passes over almost entirely from 70° to 110° . A slight oily and coloured residue remains. The greater portion distils between 70° and 90° . After several rectifications, a liquid is obtained which boils in vacuo at 80° to 82° . Analysis gave numbers corresponding sufficiently closely with the formula $C_2H_4ClSO_2$. This substance is then the result of the addition of chloric ether to anhydrous sulphuric acid. The body decomposes partially at each distillation, evolving a little hydrochloric acid, and the residue becomes thereby enriched in free sulphuric acid. The oil is nearly insoluble in water; it dissolves in hot water, decomposing slightly. Heated with water in a sealed tube to 100° it gives ordinary ether, a little chloric ether, and hydrochloric acid, while the whole of the sulphur passes into the state of sulphuric acid. With alcohol the same reaction is produced, but the alcohol reproduces chloride of ethyl. With acetate of soda in concentrated aqueous solution, acetate of ethyl, sulphate of soda, and free acetic acid are produced. These various reactions lead to one of the three following isomeric formulæ:—

Chloroæthionie acid. Chloride of isethionyl. Chlorosulphuric ether.



M. de Purgold has verified the third hypothesis.

Zinc-ethyl does not act at the ordinary temperature on bichlorinated acetal, even after several days' contact; but if the mixture of the two compounds be heated to 140° in a cohobating flask, an action is manifest by the regular evolution of gas, and as a residue ether mixed with oxide and chloride of zinc is obtained. Upon passing the gas through a tube surrounded by a freezing mixture, and

afterwards into bromine, in the cooled receiver, M. Paterno collected chloride of ethyl; the bromine absorbed a portion of gas which had not condensed. The bromine thus obtained boiled between 130° and 142° ; it yielded by analysis, for the bromine, numbers intermediate between those required by theory for bromide of ethylene and bromide of propylene. The gases not absorbed by bromine were considered to be due to secondary reactions.

M. Lieben having demonstrated that by the action of chlorine on hydrated alcohol the chlorinated derivatives of acetal were formed, explained the formation of chloral by the action of chlorine on absolute alcohol, by supposing first the formation of trichlorinated acetal, and afterwards by the action of hydrochloric acid, the splitting up of the trichlorinated acetal into chloride of ethyl and trichlorinated aldehyd (chloral). This explanation is confirmed, on the one side by the fact observed by M. Stas, of the existence of acetal among the products of the action of chlorine on alcohol; and on the other side, by the decomposition observed by M. Wurtz and by M. Beilstein, of acetal in contact with acetic acid, into ethylic acetate and aldehyd. M. Paterno proposed to himself the verification by experiment of M. Lieben's supposition, by studying the transformation of the chlorinated derivatives of acetal in presence of acids, and at the same time preparing by this means the chlorinated derivatives of aldehyd that have not been directly obtained. The bichlorinated acetal, which is easily prepared by the action of chlorine on alcohol at 80° , was chosen for the experiments. M. Paterno submitted this bichlorinated acetal to the action of sulphuric acid, and thus obtained bichlorinated aldehyd, $\text{C}_2\text{H}_2\text{Cl}_2\text{O}$, isomeric with chloride of chloroacetyl, $\text{C}_2\text{H}_3\text{Cl}_2\text{O}$, obtained by M. Wurtz. This reaction confirms the supposition, that in bichlorinated acetal the two atoms of chlorine are united to the same atom of carbon, analogous to that observed in other chlorinated products of the fatty series. The following are details of the experiments:—In the preparation of the bichlorinated aldehyd, a mixture of bichlorinated acetal, with four to six volumes of ordinary sulphuric acid, was distilled; the distillation is most conveniently made with an oil bath heated to 130° . The distillate requires several rectifications; that which passes over between 88° and 90° is pure bichlorinated aldehyd. It constitutes a very mobile liquid, heavier than water, in which it is soluble; it dissolves also in alcohol and in ether. A portion of this liquid preserved in a sealed tube suffered no change; but another portion, preserved in stoppered flasks, became thick, and finally assumed the form of a white amorphous solid. This modification of bichlorinated aldehyd, corresponding probably to the insoluble chloral, heated to about 120° , distils regenerating liquid bichlorinated aldehyd. The analytical results and the vapour density of the product agreed with the requirements of the formula, $\text{C}_2\text{H}_2\text{Cl}_2\text{O}$. These experiments were made in the laboratory of the University of Palermo, under the direction of M. Cannizzaro, and will be continued.

The only paper of chemical interest presented at the meeting on the 24th of August was a note "On the Colouration of Peroxide of Nitrogen," by M. Salet.

The vapour of peroxide of nitrogen (hyponitric acid) presents some remarkable peculiarities. Its density decreases rapidly up to 43° ; then this decrease becomes less noticeable, and at 150° is nil. At the same time the vapour assumes a deeper and deeper tint. M. Wurtz supposes that the molecule of peroxide of nitrogen at a low temperature contains $\text{N}_2\text{O}_4 = 2$ volumes, and that when heated it is gradually dissociated into two molecules of NO_2 , occupying each two volumes. M. Salet states the following hypothesis:—"Since the peroxide of nitrogen is colourless at a temperature at which its vapour density corresponds truly to the formula N_2O_4 , and since it becomes coloured in proportion as the temperature at which the molecular condensation corresponds to the formula NO_2 is

approached, let us suppose that N_2O_4 is colourless and that NO_2 is coloured." M. Salet has verified this hypothesis experimentally.

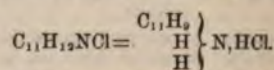
PARIS, AUGUST 31ST, 1868.

Menaphthylamine—Caproic and Caprylic Fermentation of Ethylic Alcohol.—Formation of Caproic Alcohol in the Caproic Fermentation of Common Alcohol.

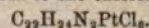
AMONG the memoirs presented to the Academy on August 31st, were the following:—"On the Induction Spark," by M. Seguin; "Protoxide of Nitrogen as an Anæsthetic Agent," by M. Evan; "Density of Uranium," by M. Peligot; "New Exciting Liquid for Bunsen's Battery," by M. Delaurier; "On the Spontaneous Alcoholic and Acetic Fermentation of Eggs," by M. Béchamp. We may possibly return to one or two of these papers.

At the meeting on September 7th, M. Hofmann contributed a note on menaphthylamine, M. Delaurier addressed a further note relative to a new modification of Daniell's battery, and from M. Béchamp there were two memoirs "On the Caproic and Caprylic Fermentation of Ethylic Alcohol" and "On the Formation of Caproic Alcohol in the Caproic Fermentation of Common Alcohol."

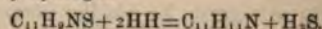
M. Hofmann was led from the preparation of menaphthylamine oxalic acid, by means of cyanide of naphthyl, to study the behaviour of this latter body under the influence of nascent hydrogen, with a view to the formation of the primary menaphthyllic monamine. Hydrogen only combines with cyanide of naphthyl with extreme slowness. After a week's treatment with zinc and hydrochloric acid, the cyanide only furnished a little menaphthylamine, while there remained with the unaltered cyanide menaphthoxylamide and likewise menaphthoxylic acid. In the presence of this difficulty, the idea suggested itself of reducing the sulphuretted amide, which is easily prepared with the aid of nitrile. The experiment completely succeeded. Upon treating an alcoholic solution of menaphthothiamide with hydrochloric acid and zinc, torrents of sulphuretted hydrogen were developed. By continuing this treatment until sulphuretted hydrogen is no longer given off, which requires two or three days, a solution is obtained from which scarcely anything is precipitated by water. Then concentrated solution of soda is added until the oxide of zinc precipitated is dissolved; an oily layer, still containing much alcohol and soda, soon rises to the surface. The oily layer is removed by a pipette, and heated upon the water-bath to free it from alcohol. There remains an aqueous solution of soda, on which floats a yellowish oil; this oil is menaphthylamine, only containing a small quantity of cyanide of naphthyl regenerated from the thiamide. By treatment with hydrochloric acid the nitrile is left insoluble; the addition of soda causes the separation of the base in a state of purity. Menaphthylamine is an extremely caustic liquid, having a point of ebullition between 290° and 293° . Recently distilled, it is colourless; but it soon acquires a yellow tint. Carbonic acid is absorbed by it with such avidity that a pellicle of carbonate is formed in merely transferring the liquid from one vessel to another. The composition of this base was given by theory, but it has nevertheless been established by the analysis of the chloride and of the platonic salt. The chloride crystallises easily in long needles, difficultly soluble in water, having the composition—



The yellow crystalline precipitate which is formed upon adding chloride of platinum to the chloride, contains—



Thus the formation of menaphthylamine by means of its thiamide is seen to be simply the replacement of two atoms of sulphur by hydrogen—



The salts of menaphthylamine are easily crystallised. The sulphate and nitrate are difficultly soluble; the crystals of the latter resemble saltpetre. In contact with sulphide of carbon, menaphthylamine becomes a crystalline mass; in contact with alcoholic soda and chloroform, formo-menaphthyl-nitrile is produced. M. Hofmann has likewise prepared benzylamine by means of thio-benzamide.

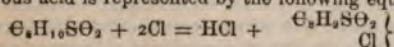
M. Béchamp remarks that ordinary alcohol can ferment. For this, it suffices to dilute the alcohol, introduce chalk containing microzymas, and a little syntonine or washed meat. The chief products of the reaction are caproic acid and hydride of methyl; at the same time hydrogen and carbonic acid are evolved, but this latter gas occurs exclusively from the carbonate of lime of the chalk. The caproic acid is accompanied by other acids, some more and others less volatile. Acetic, valeric, caproic, and caprylic acids have been isolated.

The crude product of the caproic fermentation of alcohol possesses an aromatic odour, resembling that of fusel oil. The untransformed alcohol separated has the same odour. This alcohol being rectified, there passes at the end a liquid which renders water milky. It is in these last portions that the caproic alcohol is found; resort was had to fractional distillation to place this in evidence. The alcoholic mixture was rectified a great number of times upon caustic potash, a part of the ultimate products being taken each time from the point when they commenced to render water milky. A final rectification on fresh caustic potash precluded the presence of ethers or fatty acids. The products thus obtained were oxidised by the "classical mixture" of bichromate of potash and sulphuric acid, the acid liquid distilled being separated by a rectification on carbonate of soda, from the aldehyds and ethers formed; these, oxidising in their turn, furnished a fresh quantity of acid, and so on. At a certain moment the oxidised product had the odour of valeric aldehyd. The salts of soda obtained were separated from the acetate by crystallisation; decomposed finally by sulphuric acid, they furnished a layer of oily acids, the caproic and valeric odour of which left no doubt as to their nature. These acids transformed into baryta salts, were separated according to the process formerly employed by M. Chevreul. M. Béchamp obtained a notable quantity of caproate of baryta, which he analysed; but caproic acid does not alone exist in the mixture, for amongst the baryta salts obtained there are some more and others less soluble than the caproate. The two memoirs by M. Béchamp refer to the same subject; each has contributed a part to your correspondent's account of these interesting experiments.

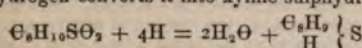
CHEMICAL NOTICES FROM FOREIGN SOURCES.

Xyloisulphurous Acid and Derivatives of Benzol.

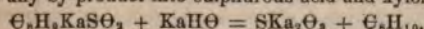
—F. Lindow and R. Otto. Xylol, of the boiling point 139°—141° C., obtained by fractional distillation of coal-tar oil, was converted into sulphonylic chloride and then by means of sodium amalgam into xyloisulphurous acid. The latter thus obtained is a slightly yellow, nearly odourless oil, soluble in ether, benzol, and alcohol, insoluble in boiling water. When exposed to air it is gradually oxidised to xyloisulphuric acid. The action of chlorine upon xyloisulphurous acid is represented by the following equation:—



Nascent hydrogen converts it into xyllic sulphhydrate:—



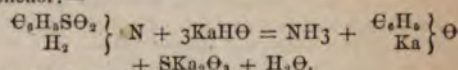
Fusing potassic hydrate decomposes it without the formation of any by-product into sulphurous acid and xylol:—



When heated with water in a sealed tube xyloisulphuric acid and oxyxylic disulphide, $\text{C}_6\text{H}_7\text{S}_2\text{O}_2$, are formed. The latter on being treated with zinc and sulphuric acid is readily

converted into xyllic sulphhydrate. An alcoholic solution of xyloisulphurous acid is energetically acted upon by nitrous acid, and after a prolonged treatment the solution contains nitrosulphoxylic acid.

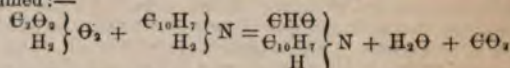
If 1 molecule of sulphobenzolic amide and 2 molecules of potassic hydrate are heated together to the fusion temperature of the amide, a violent reaction takes place, the product of which the author believes to be a substituted amide having part of its typical hydrogen replaced by potassium. It is soluble in water, and on addition of acids the original sulphobenzolic amide is precipitated. On heating the mixture to 250°—300° the amide is decomposed into sulphurous acid and phenol:—



—(Zeitschr. Ch. N.F. iv., 37.)

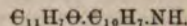
Formation of Argentic Peroxide by Ozone.—F. Wöhler. If an electric current from a couple of cells of Bunsen's battery, the positive pole of which consists of a silver plate, is made to pass through water acidulated with sulphuric acid, the silver becomes covered with a black coating of amorphous argentic peroxide. The formation of this oxide is due to ozone, for on substituting a platinum foil for the one of silver the smell of ozone may be at once recognized. The same phenomenon takes place if instead of acidulated water a solution of sodic sulphate is used. No peroxide is formed in a solution of potassic nitrate; the liquid gets filled with a flocculent light brown precipitate of argentic oxide. In a solution of potassic ferrocyanide the silver becomes covered with a white film of amorphous argentic ferrocyanide, and in one of potassic dichromate with a reddish black film of crystallized argentic chromate.—(Göttinger Nachr., 1868, 139.)

Menaphthoxylic Acid and its Derivatives.—A. W. Hofmann. The reaction by which the author obtained benzoic acid from aniline and toluic acid from toluidine he has made use of for the production of menaphthoxylic acid (naphtalene-carboxylic acid) from naphtalene. (Ann. Chem. Pharm., cxlii., 121.) On distilling the primary naphtylaminic oxalate a distillate rich in naphtylformamide is obtained:—



and on treating this product with chlorhydric acid, and distilling in a current of steam, the nitrile of naphtalene-carboxylic acid is carried over. This nitrile, after re-crystallization from alcohol, fuses at 33.5° C., and boils at 296.5°. It combines with ammoniac sulphhydrate, forming the crystalline compound, $\text{C}_{10}\text{H}_7\text{NS}$.

Naphtalene carboxylic amide, $\text{C}_{10}\text{H}_7\cdot\text{O}\cdot\text{NH}_2$, is obtained by dissolving the nitrile in alcoholic sodic hydrate and precipitating with water. It fuses at 204°. Naphtalene-carboxylic acid, $\text{C}_{10}\text{H}_7\cdot\text{O}\cdot\text{OH}$, is formed by a prolonged treatment of the nitrile or amide with aqueous sodic hydrate, and separated by precipitation with chlorhydric acid. It fuses at 160°, is sparingly soluble in water, more readily in hot alcohol. The chloride, $\text{C}_{10}\text{H}_7\cdot\text{O}\cdot\text{Cl}$, which is obtained by mixing four parts of the amide with five of phosphoric chloride, gives with ammonia the amide of the acid; with aniline the anilid, $\text{C}_{10}\text{H}_7\cdot\text{O}\cdot\text{C}_6\text{H}_5\cdot\text{HN}$; with naphtylamine naphtalene-carboxyl-naphtylamide—

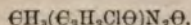


The anhydride of naphtalene-carboxylic acid, $(\text{C}_{10}\text{H}_7\cdot\text{O})_2\text{O}$, is obtained by heating the chloride or calcic salt to 140°. It fuses at 145°, is insoluble in water, sparingly soluble in alcohol, readily in ether and in benzol.

The author concludes by remarking that the acid here described is most probably identical with the naphtalene-carboxylic acid of V. Merz (CHEMICAL NEWS, No. 460, page 151 (Am. Repr. Nov., '68, page 269).—(Deutsch. Chem. Ges., Berlin, 1868, 38.)

Xenol.—E. Wroblevsky. To convert xylol into xenol (oxyxylol), $C_6H_2(CH_3)(HO)$, a solution of potassic xyloisulphate is mixed with potassic hydrate, the solution evaporated to dryness, and the dry mass heated to $300^\circ C.$ for one hour. Water is then added with a little chlorhydric acid and the xenol distilled off in a current of steam. Xenol thus prepared is a liquid, boils at 214.2° (corr.), is sparingly soluble in water, readily in alcohol and ether. It is readily acted upon by bromine, being converted into tribromxenol, $C_6H_2Br_3O$, a yellow crystalline body fusing at 141° , insoluble in water, soluble in alcohol. The action of sodium and carbonic anhydride upon xenol gives rise to the formation of xylenic acid, $C_6H_4O_2$. This acid when re-crystallised from hot water is obtained in white crystals which fuse at 155° . An aqueous solution is coloured violet on addition of ferric chloride. The composition of its baric salt is $(C_6H_4O_2)_2Ba + H_2O$. The properties of xylenic acid distinguish it from phloretinic acid, and likewise from its two other isomers—tropaic and mellitic acid. —(*Zeitschr. Ch.*, N. F. iv., 232.)

Chloracetic Acid.—N. Fazukowitsch. Chlorinated chloracetylene is most readily prepared by passing chlorine into chloracetylene containing iodine. Distillation of the raw material over copper renders it chemically pure; boiling point $106^\circ C.$ On mixing chloracetylene chloride with an equivalent proportion of water, the whole is converted into chloracetic acid. By the action of chloracetylene chloride upon urea, the compound



is formed. The chloracetic urea is acted upon by potassic cyanide, and amongst the products of this reaction the author expects to find Carbituric acid. —(*Ibid.*, N. F. iv., 234.)

NOTICES OF BOOKS.

Scientific Blue Books, No. II. Ninth Report of the Medical Officer of the Privy Council, with Appendix. London. (Continued from *Am. Repr.*, Nov. 1868, p. 270.)

It has already been shown in a few words that sufficient guarantees have been given by Dr. Thudicum for the accuracy of his observations, and this is of importance directly to the value of his results. It must be added that verbal descriptions are not exclusively relied upon, but we are further supplied with upwards of twenty diagrams, and these are of two kinds. The well-known method of Bunsen, adopted by him in his researches on Erbium and Didymium, is employed in the first place; thus the intensity of the absorption bands being graduated and fixed by degrees, such bands are diagrammatically represented by a cone of which the base represents the entire marginal width in the spectrum, and the entire cone projects towards the opposite margin proportionately to the blackness of the band. As is remarked in the context the advantage of this consists in its capability of being employed in text books with ordinary letter press, where shading off of degrees of darkness is practically impossible.

The other method is to our thinking more satisfactory, and is after all sufficiently simple; there can be no doubt in the minds of any who will take the trouble of looking at the coloured spectra contained in the report under notice, of its ready application to ordinary text books. A method like this really is a great boon to students, and Dr. Thudicum has fairly earned their thanks for his demonstration of its success. A lithographer prepared sheets with the spectral colour imprinted in the usual succession and proportion; on these are entered the solar lines in the closest approximation to the natural places in the colours possible. If this is not done the slips are fixed upon a rack of parallel lines representing the spectrometer scale, the ends of the spectrum being first accurately adjusted. The slight drawback is to express the amount of shading belonging to each band; for this the estimate of the eye is the sole guide. A slip thus once carefully prepared may be of course reproduced, and printed by the chromo-lithographer; and to

avoid the trouble of printing them on the paper of the book, these slips may be pasted in the properly left blank intervals. It seems to us that similar slips may be similarly introduced into text books by authors; and observers by following these directions will be able to record their results for future reference.

As the chief interest of all these experiments turns upon the urine of cholera patients, it is necessary to follow Dr. Thudicum in his remarks of—first, the quantity, secondly, quality of the secretion in the disease.

As the complete suppression of the urinary secretion in collapse, lasting for hours or days, is one of the most striking and peculiar features of cholera, so its re-appearance is amongst the earliest and most auspicious signs of beginning recovery. The first secretion mostly contains the evidence of the mechanical obstruction of the minute channels of the kidneys, and of the general death of the epithelia of the urinary passages. It also contains the sign of continued resistance to the blood current through the kidneys in the form of transuded albumen of the blood. Further in many cases it carries small quantities of peculiar abnormal ingredients, which may perhaps be products or remnants of processes engendered by the choleraic process in the blood.

Out of upwards of thirty cases of cholera in which an opportunity for examining the urine was afforded, only about eighteen yielded first or early urine of reaction with characteristic properties of that stage. In several of these eighteen cases the only specimen obtained was taken from the body after death.

The first urine passed by persons recovering from collapse was mostly small in quantity, as little as six cubic centimetres being observed. After the first excretion, which afforded one limit of the measure of the secretory activity compared to time, several hours frequently elapsed before a second excretion affording the other limit took place. This yielded generally a larger amount of fluid than the first, but its measure remained greatly below the normal standard. When the urine excreted during the first twenty-four hours after the re-establishment of secretion was united and measured, it was sometimes found as low as 70 cubic centimetres, being only one-tenth of what would have been excreted in acute febrile diseases, and only one-twentieth of the normal standard of health.

To this diminution of the urinary water corresponded a great diminution in the amount of the principal ingredient, urea. In one case the total quantity of urea excreted during the first twenty-four hours after the secretion had begun amounted to only 0.9 grammes, being only about one-thirtieth part of the secretion which a healthy individual of the same weight would have produced during the same time. The urine was dilute, the urea being to water in the relation of 1.4 to 98.6. In health the urea is in round numbers 2 per cent of the urinary water, and in febrile conditions it rises to 3 and 4 per cent. There is consequently no condition of health or of febrile disease, and as far as our present knowledge goes, no other condition of body whatsoever in which chemical change as expressed by the excretion of urea may be so much diminished as in cholera.

The first urine mostly contained appreciable quantities of uric acid, but not more than would correspond to a feeble proportion in normal urine. In some cases the acid was spontaneously deposited in the crystalline state. Oxalic acid, which may be termed an accidental ingredient of normal urine, and which obtains great pathological importance in cases where its lime salt manifests a disposition to crystallise and form concretions in the body, was mostly present in first cholera-urine to the amount of several centigrammes. Of the inorganic salts chlorides were either absent or present in traces, phosphates and sulphates much diminished. The colour of first urine was mostly pale yellow, sometimes, however, saturated yellow, rarely dark. It was turbid by suspended formed ingredients, and appeared of a darker colour when these matters were removed by filtration. The colour was due to ordinary urochrome, and perhaps in part

to the admixture of one or two different bodies which with acids yield blue and red products, and which have therefore been designated as urocyaninogen and urocrubinogen. Albumen in small quantities was mostly present, rarely absent. Sometimes there were sporules single and double, and more or less developed fungi. These signs of decomposition, together with abundance of vibriones, were the more developed the more the neutral or acid reaction had passed into the alkaline, and the more the presence of ammonia carbonate was indicated by the deposition of crystals of triple-phosphate. Lime phosphate in needles and dumb-bells was also observed in cases where the decomposition had gone farther, mixed with spinous globules of soda urate. In such cases the pus cells formed the usual ropy masses of adhesive mucus.

In the torpid, tepid, and febrile stages the urine assumed properties and was excreted in quantities corresponding on the whole to the thermic conditions of the body, and the rapidity of pulse and respiration, in such a manner as on general pathological grounds from a knowledge of these conditions might have been predicted.

The earliest urine voided by choleraic patients entering upon the stage of reaction, not rarely contains a peculiar principle, which has the property of generating a blue colouring matter, when the urine is cautiously boiled with a sufficient, but not excessive, quantity of nitric acid.

This production of a blue matter from the urine of cholera patients was first observed by Gubler (*Gaz. Méd. de Paris*, Dec. 16, 1854). The usual colour of the urine which gave him the test was very pale yellow. He found the blue more evident when impure nitric acid, containing nitrous acid, was used. He never found any green tinge, but the blue persisted for some time and then faded. He believed that there was some analogy between this matter and the colouring matter of bile.

These observations were a year later confirmed by H. Osborn (*Medical Times and Gazette*, March, 1855, 307), and Lauder Lindsay (*Ibid.*, May, 1855, 460). Osborn observed that the urine of a cholera patient recovering from collapse had a dark colour and turbid appearance, was acid, and of specific gravity 1020. The addition of a little pure nitric acid changed the colour to reddish, then deep violet, and a blue powder was ultimately deposited. When nitric acid containing nitrous was used, effervescence was produced, and a brown precipitate subsided, in which the microscope discovered some blue specks; the supernatant fluid remained of a straw-colour instead of a deep violet. Hydrochloric acid acted exactly like nitric acid in producing the blue precipitate and violet colouration. The blue matter appeared soluble in alcohol. On adding a solution of potash to the blue precipitate, the solution gave, with a persalt of iron, a pale blue; and with a persalt of that metal a greenish precipitate, insoluble in hydrochloric acid. Sulphate of copper threw down a reddish brown precipitate from this solution by potash. The urine of the patient gave a less amount of blue precipitate as convalescence became established.

Subsequently Lindsay, on evaporating a mixture of the first urines of four collapse cases entering upon reaction, observed that as the fluid reached the boiling point a copious scum of a beautiful Prussian blue colour formed on the surface. Microscopically it seemed to consist wholly of urates having a blue tinge.

A Sketch of a Philosophy. Part II, Matter and Molecular Morphology. Williams and Norgate, Covent Garden.

OCCASIONALLY remarkable works fall to the lot of a reviewer; of this class is the work before us. That this statement is true, the reader would find sufficient evidence in the first few lines of the author's introduction, styled "A Hint of our Philosophy."

In the actual state of science we are told the phenomena of nature have been classified to a great extent and referred to laws, but these laws are numerous, and the acquisition of

science accordingly laborious. "Most of them (the laws) also rest solely on an inductive or empirical basis; they have been reached merely by observation, they give no account of themselves to Reason; and this places them in a very unsatisfactory position in an intellectual point of view. That the inductive method of arriving at a law of nature is the one to which least objection can be raised, we are assured all physicists and chemists will maintain." Continuing the paragraph, we find "It obliges the man of science to content himself with intellectual despair as the only kind of intellectual repose which the actual state of science allows him." This statement, to say the least of it, rather startles the man of science; he tries to imagine exactly what sort of feeling intellectual despair is.

The author remarks that some years ago he endeavoured to show that there is one general mode of action, which, when modified according to circumstances, gives all those varied modes of action which are usually regarded as laws of nature but he did not then see the reason of the law.

The first law is the cosmical or all-embracing law. This law is named from that operation of it, which is most important to us, "that by which our organisation is reintegrated and our energy maintained from hour to hour, namely, assimilation. And the reason of it appears on our considering the consequence of that view of nature which has already been alluded to, namely, that nature in the creation of an all-sufficient Creator—a view which may certainly be characterised as the most natural as well as the most respectable." But the author finds it convenient, by reason of our intellectual weakness and shortness of life, to have a number of laws to refer to, rather than one only. The all-embracing law is therefore resolved into three, and these into two sets; the two sets take their rise in the twofold fact that the finite assimilates itself on the one hand to the infinite, and on the other hand to itself. Probably the connection between the words finite and infinite suggested the first portion of the twofold fact to the author. From the assimilation of the finite to the infinite arise the law of diffusion or expansion on the one hand, and the law of individuation or condensation on the other, and as their harmonised product in the material economy, the law of the perfect in form (symmetry culminating in sphericity). From the assimilation of finite objects to one another arise the law of the permanence of the properties of matter and the law of types or species on the one hand, and the phenomena of affinity and transformation and the law of generic resemblance on the other; and as their harmonised product the law of the conservation of energy. What can any one, not upon a par with the author in intellectual capacity, make of this conclusion: "Theodicy and our theory, therefore, equally suggest a creation which shall consist wholly of spiritual, psychical, or sentient Beings?" We remember Mr. Punch quietly making a note of the use of the expression *sapient* act by a journalist, what would he say to the term *psychical* beings? The indiscriminate way in which capitals are used for being and infinite is very confusing.

This assertion will be read with interest, "these are our two 'elements' *par excellence*; hydrogen being that into which a world now dissolving tends to be resolved, as also that which is the seminal element of a new world, and thus that which connects two cycles; while azote comes out in our theory as a residuum." Illustrations of the various forms of the molecules of elements and their compounds are given; they represent symmetrical figures of great beauty. For the purpose of illustrating the doctrine of molecules, the substance sugar is taken. And here we quote in reference to this, a number of statements that we consider altogether unjustifiable, and that are certainly obnoxious to chemists, since evidently made by one possessed of a very superficial knowledge of chemical science. "Its formula in chemical works is $C_{12}H_{22}O_{11}$ (in the notation of the classical epoch of Prout, &c., when $C=6$ and $O=8$), and its specific gravity has been found 1.56—2.6. Why the specific gravity should be this rather than anything else, why $C_{11}O$ should only be insoluble as C_{12} , &c., and C_{24} , &c., are, it must

be admitted, perfect mysteries by all the light which the most advanced chemistry can throw upon such subjects."

The author, our readers have seen, prefers to use the term azote for nitrogen; likewise he prefers to use silica for silica, and to represent part of the formula of sugar, $C_{12}H_{22}O_{11}$, by Su. The two terms supplied by chemistry, atom and molecule, are also insufficient for the division of bodies; we might however add that a third one, namely mole, has already been suggested (Hofmann's Mod. Chem.). So the word molecule is cut up, and thus are obtained *u/e* or atom, an undecomposable element, *cule* a first combination of atoms, *moleule* a group of ules or cules, *moleculé*, the aggregate which is in relation with AQ the unit volume of liquids and solids, and *mole* or mass, the visible palpable object. We must explain that $AQ=aq_{10}$ is a particle or unit volume of water. It is stated that the views before enunciated imply that a system of molecular morphology, in order to be truly scientific, ought to begin with baric and barytic substances, for in the theory these are, as it were, mineral embryos, "though for their full development (blessed creatures!) they require no food, but heat only."

After reference to the water type in modern chemistry and the number of compounds constructed upon this type, another modest statement occurs: "Hence a maze of formulæ which have no response in nature, and indeed no value beyond the walls of the laboratory in which the relative experiments are conducted, or the mind of the chemist who enjoys the privilege of being their creator, or of having mastered the difficulty of conceiving what they mean, or of putting the letters in their right places upon paper." Accordingly we are told the numbers who take an interest in scientific chemistry now, compared with what they were half a century ago, are very small (?). One might add that if learners had for theory only our author's work to refer to, in another half century chemists would be working out the laws of their science by the inductive process. As an example of the terms in which other theorists' views are referred to, the following serves well: "Meanwhile physicists are proposing another theory of the constitution of aeriforms—a sort of emanation theory in bottles—a game at gas billiards—which reduces the whole to chaos."

In conclusion, we think it possible to show that the author has, at any rate as far as chemistry is concerned, very cleverly worked out the *reductio ad absurdum* for his theory. "Thus, suppose we were set out with baric and barytic combinations, a normal telluride or a sesquiselenide of tungsten, for instance, and to develop them into elements of common weight, observing the laws of morphology while doing so, we should obtain as the result of the development, molybdenite, magnesia, manganese, iron, and lead, along with tungstic and molybdic ochres." Evidently the philosopher is aware that he is an advanced thinker—in a word, a man before his time—for he adds, "but such developments belong to an advanced state of our science, of which the alphabet, alas! is more than most people will consent to learn at present."

CORRESPONDENCE.

Artificial Manure.

To the Editor of the CHEMICAL NEWS.

SIR,—I know of no branch of the public press that could render such important service at this moment to the science and practice of agriculture as that over which you preside, if you could only spare a small portion of your valuable space for the purpose of eliciting a sound opinion on the proper choice, qualities, and purchase of artificial manure. I will, therefore, with your permission, address the following observations

TO THE CHEMISTS OF GREAT BRITAIN.

Gentlemen—"I take the liberty of addressing to you a request of the greatest importance to the progress of agriculture in this country, and my excuse for taking this liberty

is that any opinion in reference to the science of agriculture that bears the sanction of your authority will be accepted by farmers and others, as not only of the highest order, but in the most perfect faith of its being given sincerely and purely in the interest of agriculture.

"The request I have to make to you—not alone in my own name, but in the name of an association formed to protect and promote agriculture—is that you will favour us with your opinion on the principles we have adopted in the choice and purchase of artificial manure.

"In this country the trade and manufacture of artificial manure is assuming gigantic proportions. At certain seasons of the year our corn exchanges are inundated with makers and their agents; every kind of 'specific' in the shape of manure is offered for sale by all sorts of people and for every kind of crop; and I need scarcely inform you that, in proportion as these artificial manures are good and useful, so are they associated with an alarming amount of deception and fraud; so much so, indeed, that, unless some very active measures are taken to expose and counteract this evil, the employment of the good and useful manures will be seriously affected, and the progress of agriculture seriously checked.

"We are doing all we can to meet this large and growing evil, by the formation of an association of practical farmers, and hope by combined effort to secure to agriculture all the advantages that science has bestowed upon it, and at the same time protect ourselves against the various costly and comparatively useless 'nostrums' and fraudulent mixtures that are prepared by mean and insignificant makers under the various titles given to artificial manures.

"That an association such as we have formed was most urgently required will be seen by the following facts:—Only a few months ago I was paying to a most respectable firm £6 10s. per ton for manure, which I am now able to purchase, of even better quality, at £4 2s. 6d.; but this reduction in the cost of manure is not, after all, the most important fact. It is still more satisfactory to know that, at all times, we may rest assured that through the watchful agency of our association any manure received will certainly have the quality and strength bargained for. Just to show the great change and progress that have been made in the manufacture and supply of phosphatic manures within a few years, I will quote from a card which gives the analysis and value of manure as supplied by one of the most honourable and respectable manufacturing firms. This manure was stated by six eminent chemists to contain an average of 18 per cent of soluble phosphate, and was valued at between £9 and £10 per ton. Now by the rule of three, if 18 per cent costs £10, the value of the manure as now supplied through our association, and containing 26 per cent, should be something over £14 per ton; again, the value of soluble phosphate was estimated at £35 per ton; at this moment, the pure soluble phosphate contained in our manure and delivered free to our members costs about twelve pounds per ton; but is it unreasonable to expect a still further reduction in the price, and improvement in the quality of these manures? Hitherto the great source from which our phosphatic manures have been procured has been the wonderful coprolite beds of Cambridgeshire, Bedfordshire, Suffolk, &c.; but recently there has been discovered phosphatic rocks in Spain and Canada, containing not less than 80 per cent of phosphate of lime. Surely it is only a question of time when these immense stores of phosphorus will be imported into this country in quantities without limit, and thus enable us to restore, not only to our arable soils, but to our grass lands as well, the phosphatic elements which for so many years have been taken from them, and which I have no doubt has been one of the chief causes of the exhaustion of our soils; and is it not probable that this immense trade will shortly fall into the hands of our large sulphuric acid makers, who will use these minerals as a convenient means for disposing of thousands of tons of sulphuric acid.

"An important principle in the conduct of our association

is this,—no exclusive or individual interest or profit can exist; whatever advantage we can secure by co-operation is entirely for the benefit of the general body of our members. Another important principle is that we purchase only one kind of artificial manure—'Superphosphate of Lime'; and we do this in obedience to what we believe is nature's simple and beautiful law—return to the soil in some shape that which you take from it. We say the crew yard, with the food consumed by stock, together with a system of cultivation that enlarges and deepens the lungs of the soil, thus enabling it to inhale and more completely nourish itself by the action of rain and the atmosphere, will in general supply everything else that can be profitably employed. Consequently every shilling that a farmer has to spend in artificial manures is spent with the greatest advantage in the purchase of phosphatic manures only.

"We do not deny that 'special manures' may not be useful in 'special cases,' but such manures must always be expensive, since there can be no competition in their supply; each maker has his own secret or patented process, in neither of which have we any faith, therefore the cost of such mixtures to the consumer must be just what the maker may be inclined to charge; but we further protest against farmers purchasing or using at any time artificial manures, the composition of which they are completely ignorant, and by so doing put themselves blindly into the hands of the manure makers. Every farmer should know what he buys, and for what purpose; without this knowledge he is no longer a farmer, but simply an agent—the manure maker usurps the intelligence of the farmer; besides such a position at all times exposes the farmer to the grossest deceptions and frauds. These very serious objections cannot occur in the purchase of phosphatic manures; their composition is well understood, and a large amount of experience has proved the many ways in which they may be profitably employed; they are besides prepared by numerous makers, and are at all times under the control of the 'Golden Economic Law' of free competition—supply and demand. In the purchase of these manures the farmer knows exactly what he buys, and by becoming a member of an association such as we advocate, he ensures for himself a phosphatic manure of certified quantity at the very lowest cost.

"I hope that I have clearly explained the purpose of our association, in its chief principle, which we earnestly advocate, viz., the use and function of one kind of artificial manure. We believe we are only putting into practice the laws and opinions which have been long advocated in the many works and contributions to the science of agriculture. Should these observations be successful in eliciting the opinions of chemists, I hope they may be of a thoroughly practical character. It will be of no use to say certain materials would be valuable additions to the simple phosphatic manure, unless they can be procured in any quantity and at prices that will make it worth while. Manure makers are too ready to talk of the absence of nitrogen or ammonia, potash, magnesia, &c.; but supposing these substances to be necessary or useful, can they be purchased to pay, and does not Nature supply the most important of them—nitrogen—free of all cost if man will only perform his part in the preparation of the soil? Do we not always find, when we read Nature aright, that all the large requirements for the sustentation of vegetable and animal life are ever at hand? if this is not the case, why have we six million pounds of nitrogen constantly pressing on ever acre of land? why have the wonderful discoveries of the spectroscope revealed to us that the salts of the ocean, especially soda, are to be found everywhere, even on the tops of our highest mountains.

"In conclusion, allow me to observe that, should the objects of our association have the valuable support of your favourable opinion, it will then only remain for time, patience, and perseverance to complete our task and to make our association an example to be usefully and profitably followed by every other part of this great agricultural

country."—I have the honour to be, gentlemen, in the name of the South Lincoln Tillage Association, your obedient servant,

WILLIAM LITTLE.

Heckington Hall, Lincolnshire, October, 1868.

NOTE.—I shall be glad to forward the rules and regulations of our association by post to any person who may require them.

A New Scientific Club.

To the Editor of the CHEMICAL NEWS.

SIR,—If Mr. Lippincott would kindly charge himself with laying down a code of rules, he will greatly conduce to the desideratum of uniformity of observation as to ozone. I am glad to see his strong assertion of the value of this.

For several years it has been an idea of mine to associate myself with several other men interested in scientific questions, and, whilst each of us should more especially pursue his own branch—as mineralogy, geology, meteorology, botany, &c.—that we should all agree to work together, and all daily to make the same set of observations at different heights. I hope next year to develop this scheme.

With regard to the field of work, there are two plans which suggest themselves: either for one of us—and I volunteer—to reside several weeks at the summit of the pass of St. Theodule, 10,900 feet above the Mediterranean, and the highest point in Europe, where a long stay would be practicable, whilst others among us observed at lower elevations; or, perhaps as good a plan, to use my own yacht, charged with instruments, for a scientific trip to Norway, and as our base of operations, taking a tent up to some well selected point of great elevation, or to several.

It is to be regretted that there is no real 'Traveller's Club'; nor, unless the "Journal of Travel" should supply the hiatus, is there any periodical at which peripatetic philosophers would look to meet with proposed organisations, mutual requirements, and so forth.

I have found it almost impossible to hear privately of fellow labourers willing to organise a mutually aiding trip.

I appeal to you, Sir, to afford me this chance through your valuable columns; and, that any may write direct to me, besides the response I hope to see in the CHEMICAL NEWS, I enclose my card, and am, &c.,

"PER MARE PER TERRAM."

October 24, 1868.

Supports for Eudiometers.

To the Editor of the CHEMICAL NEWS.

SIR,—It may be a matter of interest to readers of the CHEMICAL NEWS engaged in the analysis of gases by Bunsen's methods, if I place on record a device to which I have had recourse for the support of the eudiometers. Six months ago I used with more or less success wooden screw clamps, but in many instances such supports have no claim to the title, and are often, from their construction, quite unfitted for the purpose intended. I need not enumerate the defects in the so-called universal holder, light at its foot and weak in its joints, a very contradiction of its profession. I shall pass over the support figured on page 22 of Bunsen's "Gasometry" as being a fixture to the table, and remark that I prefer freely to suspend the eudiometer so as to allow the instrument to assume a vertical position. This is easily and satisfactorily accomplished, as follows:—Two pieces of thin copper binding wire of equal length are placed side by side and twisted together in the middle so as to form a circular loop; this is done by aid of a glass rod. The length of wire so twisted may be five millimetres. The four free extremities are next somewhat flattened, so that when placed over the head of the tube they shall lie closely to the glass at equidistant points; in this position they are to be carefully bound

to the tube with waxed thread for a length of ten millimetres. So secured, the wire will remain attached under a strain of fourteen pounds. The support, from which the tube is suspended by a steel hook, consists of a cross bar of wood or metal resting on two uprights, the feet of which are heavy and fit closely against the ends of the trough. One of the uprights should be cut away in such a manner as to allow a tube to be passed through, that it may lie in the felt-covered groove. From the cross bars hang several hooks of lengths adapted to the various eudiometers. The arrangement as here described is one I have used for the last six months. Its simplicity, and the ease with which the tubes are placed in position and removed, are its chief recommendations. Again, several tubes, if required, can be suspended in the same manner; the meniscus of each in no way obscured by shadows thrown from its neighbour.

The only point requiring alteration is to carefully centre the loop of copper wire before the binding is made secure. Some apology is perhaps due for bringing into prominent notice a matter so simple. I must, however, allow the substance of the letter to plead its own cause at the bar of opinion.—I am, &c.,

P. HOLLAND.

September 22.

Wanklyn & Chapman's "Water Analysis."

To the Editor of the CHEMICAL NEWS.

SIR.—The review of our book on "Water Analysis," with which you favoured us and your readers generally last week (*Am. Rep.*, Nov. '68, p. 270), is mixed up with other matter which requires some notice from us.

As to the review properly so called, there is no necessity for us to discuss it at all, and we shall content ourselves with expressing our sense of the unusual magnitude of the space in the columns of your valuable journal which has been devoted to it. Neither is there the smallest necessity for us to defend ourselves from the charge of over-hasty publication, which is levelled at us by the reviewer, nor from that of bringing out "raw, incomplete, and sometimes inaccurate results;" all this must be regarded as a compliment, the like of which is occasionally paid us by certain chemists whose activity does not take the direction of the original research.

But, either from inadvertence or from some other cause, the reviewer has been betrayed into some misstatements. Thus our strictly formal quotation from Dr. Noad's book is described as a copying;—"copied from Dr. Noad's Qualitative Analysis," writes our critic. In literary circles the use of such an expression is, we believe, restricted to the description of a quotation or paraphrase made without acknowledgment. Moreover, this quotation is merely subsidiary, not being, as the reviewer would seem to imply, the description of the details of the soap-test in the form which we prefer to recommend for general adoption.

On the subject of the controversy respecting Dr. Frankland and Mr. Armstrong's method, which our critic regards as "very elaborate and most elegant," fault is found with us for not being able to assert that we have tried it. However, the set of test-determinations published by Dr. Frankland and Mr. Armstrong, for the purpose of exhibiting the capabilities of their method, and which does exhibit it as having arrived at so high a pitch of perfection as to be affected by an average error of only half a milligramme of organic carbon or nitrogen in a litre of water, relieves chemists from the duty of examining it experimentally for themselves. At any rate, under these circumstances no blame can rest on us, who do not question the possibility of reaching this degree of precision, but who have simply pointed out that a litre of most kinds of natural water contains less than half a milligramme of organic nitrogen.

The reviewer is in error in the account given by him of the origin and history of our ammonia process. It did not originate in the oxidation process, as our reviewer represents it to have done; neither is it quite correct to say that

it was first announced on the 20th of June, in a paper read to the Chemical Society. Before that date it had been given very explicitly, but in a rudimentary state, in the pages of "The Laboratory."

Our reviewer's account of the contents of our various papers bearing on this subject is, for the most part, a misrepresentation diversified by positive misstatements. We will not waste your valuable space by entering into detail, but, should the errors of our critic take root in the chemical mind, may possibly refer to them at some future time. Mr. Dugald Campbell's results were contradicted in "The Laboratory" within a fortnight of their publication. They were again denied emphatically at a meeting of the Chemical Society, and were not maintained even by himself. They were subsequently denied by Mr. Philip Holland in the pages of this journal, and have never been confirmed by any one.

With regard to the advice given to us, no doubt very kindly, towards the end of the review, "not to imagine that chemists are prejudiced against it" (our ammonia process) "because they hesitate to accept evidence so inconclusive," &c., we have to say that our complaint is of another kind—viz., that it has been precipitately adopted without being either acknowledged or understood. In the interval between the reading of our paper to the Chemical Society and the publication of the number of the Chemical Society's Journal containing the description of our process, chemists were to be found who, trusting to their recollection of what had been read to them, or depending on a reporter, did not scruple to undertake the working of our ammonia process for the Government, without our co-operation or knowledge.—We are,

Your humble and obedient servants,

J. ALFRED WANKLYN.
ERNEST T. CHAPMAN.

Laboratory, London Institution,
Sept. 28, 1868.

[We take a somewhat unusual course in printing the above review of our review, and we do so, firstly, because the subject it refers to is of great importance, and secondly, because we are anxious to enable our readers to form as impartial an opinion as possible on the question at issue.

It is scarcely worth while to answer in detail all the petulant objections taken by our correspondents. We did write "copied" instead of "quoted," and if the "literary circles," to whose somewhat vague tribunal we are referred, decide that copied means pirated, we must bow in meek submission: in the meantime we will take leave to consider the objection a quibble. The various chemists whom our irritable authors attack can very well defend themselves, and to them we leave the task. We are not much afraid that the high reputation which has hitherto marked the names of Frankland, Odling, and Campbell, will suffer much diminution, even from the assaults of these redoubtable champions.

As for our reviewer, and the aspersions cast upon his veracity, he exhibits, we are grieved to say, anything but a contrite spirit, and even aggravates his offence by reiterating all his statements. He urges that his account of the history of the ammonia process is, in the main, perfectly correct; that the papers which appeared in "The Laboratory" contained no notice of the process as it was afterwards published, and in particular no allusion to permanganate of potash; that the earlier papers contained important statements which were contradicted in the later ones; and generally, that the original publication was in an eminent degree "raw, incomplete, and inaccurate."

He has sent us, in justification of his opinions, the following quotations from some of the authors' published papers,

and we are so far influenced by them as to refrain for the present from holding him up to general execration:—

WANKLYN. *Laboratory*, May 11, 1867, p. 93.

"The organic impurities to be deared in a water are nitrogenous. During the evaporation of a water these nitrogenous compounds give up their nitrogen in the form of ammonia. Distill therefore a given volume of the water in a retort and estimate the ammonia in the distillate, and you have a trustworthy measure of the much-dreaded organic impurities in your water."

WANKLYN, CHAPMAN, AND SMITH. *Journal of the Chemical Society*, xx., 448.

"Direct experiments in which a known quantity of urea, gelatin, and albumen were taken, have shown that all the nitrogen present in these substances is obtainable in the form of ammonia when they are subjected to the treatment about to be described (the ammonia method), and has disclosed the very singular fact that boiling with a caustic alkali liberates one-third of the nitrogen, both of albumen and of gelatin in the form of ammonia, and that a subsequent boiling with permanganate of potash liberates the other two-thirds."

WANKLYN. *Journal of the Chemical Society*, xx., 594, 595.

"Perfectly pure urea in perfectly pure di-tilled water may be boiled for a long time with carbonate of soda, or with potash, without giving off ammonia."

"The same urea dissolved in a town water containing '07 milligrammes of albumenoid ammonia per litre gave a slow evolution of ammonia, becoming after a time quicker."

"Boiling with caustic potash and then with permanganate of potash, gives off only about two-thirds of the ammonia which albumen contains."

Passages like these speak for themselves, and we can only conclude by reiterating our regret that scientific men of such undoubted abilities should labour so hard to prove to the world that they are as wanting in scientific caution and accuracy as they are in the more important attributes of good taste and good temper.—*Ed. C. N.*]

Alloy of Tungsten and Iron.

To the Editor of the CHEMICAL NEWS.

SIR,—If you think there is any novelty in the following Laboratory Note, I will thank you to give it insertion in the CHEMICAL NEWS:—

At a foundry in this city (Dublin) it was lately observed that some masses of pig-iron thrown into the furnace could not be brought to a sufficiently liquid state for casting; and some small fragments of one of these lumps were brought to my laboratory by a friend, for the purpose of ascertaining the cause of their difficult fusibility. They had a metallic lustre, a colour similar to that of grey pig-iron, were brittle, very hard, and possessed in several parts a vesicular structure. Their specific gravity was as high as 10.125; they were attracted by the magnet, but in a considerably less degree than pig-iron.

In muriatic acid they were partially dissolved with evolution of hydrogen. The solution, however, was incomplete, and there remained undissolved better than half the weight of the metal subjected to the action of the acid.

A second portion of this metallic material from the foundry was acted upon by aqua regia, when a yellow insoluble substance made its appearance, which was found to be tungstic acid, as it exhibited the following properties:—

It was insoluble in water or acids, and after ignition acquired a straw-yellow colour; but when placed upon a filter and washed with water, it became white and then gradually passed through the filter. In water of ammonia it readily dissolved, and the solution, when placed in contact with zinc and supersaturated by muriatic acid gave a white gelatinous precipitate, which rapidly acquired a blue colour.

A drop of the ammoniacal solution dried on a platinum wire, and fused in the reducing flame of a blowpipe with salt of phosphorus, gave a blue bead, and then, when heated in same flame with a minute particle of green vitriol, became blood-red.

* The italics are ours.—*Ed. C. N.*

From these experiments it appeared that the heavy metal from the foundry was an alloy including a considerable quantity of tungsten.

A number of experiments were now made for the purpose of determining its exact composition, and the following final results were obtained:—

Tungsten.....	38.23
Iron.....	61.77
	100.00

Numbers which correspond pretty accurately with the formula Fe_{11}W_2 . Of the 61.77 grains of iron, 41.46 are taken up by hydrochloric acid. The residue, amounting to 20.31 grains, had to be removed by fluxing the undissolved portion of the alloy with a mixture of nitre, carbonate of soda, and common salt, by which the iron was oxidised and the tungsten converted into tungstic acid.—*I am, &c.,*

J. A.

Dublin, October 3, 1868.

Wanklyn & Chapman's "Water Analysis."

To the Editor of the CHEMICAL NEWS.

SIR,—You will allow me in justice to myself and to Messrs. Wanklyn and Chapman, who have brought my name forward in support of some of their statements connected with the "Ammonia Process," to point out exactly in what my testimony consists.

THE CHEMICAL NEWS of November 29, 1867 (*Am. Repr.*, Jan. 1868, page 52), contains a letter of mine, wherein I drew attention to the advisability of representing in degrees of "organic nitrogen" the ammonia evolved from natural waters when submitted to the successive action of sodic carbonate and potassic permanganate. As illustrations of my scheme, I gave analyses of three waters made by the "Ammonia Process."

At the close of the letter I said—

"Water No. 1 confirms Professor Wanklyn's statement in the *Laboratory* (No. 26, page 442), with reference to the stability of albumenoid matter in the presence of a boiling solution of sodic carbonate of the strength used by himself and colleagues in their process."

The water in question did not give any ammonia when a litre was distilled with carefully purified sodic carbonate, though it yielded an appreciable quantity after the addition of the permanganate. This experiment shows that some waters, although they do not give ammonia by distillation with sodic carbonate, yet contain a nitrogenous substance of greater or less complexity, capable of being totally or in part converted into ammonia by potassic permanganate. This substance, whatever it may be, has been called albumenoid matter, for want I take it of a more exact definition.

So far, then, as regards natural waters, my experience accords with that of the authors' in the one particular I have mentioned. To turn to another part of the subject, viz., the stability of albumen proper (white of egg) when distilled with sodic carbonate, test experiments gave me anomalous results, equal weights of different samples yielding unequal weights of ammonia. An observation led me to infer that white of egg contains, perhaps, traces of some ammonia salt or derivative variable in amount in different specimens, and that it is to the presence of such salt that the traces of ammonia found in the distillate are to be ascribed. Again, the small quantity of ammonia evolved by the soda treatment from large quantities of albumen, taken in conjunction with the fact that after a while the evolution ceases, point rather to the same conclusion.

As an impartial observer I consider the choice of the words "Albumenoid Matter," by the authors unfortunate; had they hit upon some other term, they would in all

probability have been spared the refutation of much of that criticism, based on the assumption that albumen and albumenoid matter are necessarily synonymous expressions.—I am, &c.,

Chorley, October 3, 1868.

PHILIP HOLLAND.

A Question in Thermotics.

To the Editor of the CHEMICAL NEWS.

SIR,—Would you oblige me by explaining the following point?—

The total quantity of heat required to convert 1 gramme of water at 0° C. into steam at 100° C. is

$$(100 \cdot 5 + 536 \cdot 5) = 637 \text{ heat units;}$$

according to Regnault's formula,

$$Q = 305 \cdot t + 606 \cdot 5,$$

the quantity is

$$30 \cdot 5 + 606 \cdot 5 = 637.$$

But the quantity of heat, latent and sensible, in 1 gramme of steam at 100° C. is less than 637 units; for since the specific heat of steam is $\cdot 4805$, the quantity of sensible heat in 1 gramme of it at 100° C. is

$$\cdot 4805 \times 100 = 480 \cdot 5;$$

and the quantity of latent heat is $536 \cdot 5$.

Hence the total quantity of steam in 1 gramme of steam at 100° C. is

$$480 \cdot 5 + 536 \cdot 5 = 584 \cdot 55.$$

Consequently it appears to me that, while 637 heat units have to be added to 1 gramme of water at 0° in order to convert it into steam at 103°, only 584·55 heat units have to be removed from the steam to get it into water at 0°.—I am, &c.

VOLTA.

A Question in Thermotics.

To the Editor of the CHEMICAL NEWS.

SIR,—“Volta” (*Am. Repr. Dec. '68, page 338*) will find that he has assumed, without proof, that the latent heat of steam is the same at 0° C. as it is at 100° C. This is not the case. According to Regnault's results, the latent heat of steam at 0° C. is 606·5, instead of 537. There is a further error in taking $\cdot 4805$ for the specific heat of steam. The specific heat to be employed is the true specific heat—viz., that at constant volume. The specific heat of steam at constant volume, referred to that of an equal weight of water as unity, is 0·369. Using this number, we have by this second method of calculation for the total quantity of heat in 1 gr. of steam at 100° C., $36 \cdot 9 + 606 \cdot 5 = 643 \cdot 4$, a result sufficiently near to 637.

It is probable that the specific heat of steam between 0° C. and 100° C. is less than the specific heat at 100° C.; and the number 0·369 was obtained by Regnault at temperatures above 100° C. It is obvious that if we possess a sufficiently accurate determination of the latent heat of steam at 0° C., this method will enable us to calculate the specific heat between 0° and 100° C. from that at 100° C.—I am, &c.,

W. MARSHALL WATTS.

Ozone.

To the Editor of the CHEMICAL NEWS.

SIR,—It may, perhaps, prove interesting to some of your readers if I point out three sources of error to which many of the discrepancies in the registration of ozone may be due.

1st. The test-papers employed are not of uniform quality—some are more sensitive than others.

2nd. There does not appear to be any uniform method

adopted of exposing the test papers to the influence of the atmosphere.

The amount of ozone present, as indicated by test-papers exposed in various ways (as, for instance, in Moffat's ozonometer box, Sir James Clarke's ozone cage, or from the roof of a thermometer-stand), will vary most considerably, and be a source of the greatest confusion. To give an example:—From July 30th to September 24th, 1862, Mr. Atkinson simultaneously exposed two sets of similar test-papers—one set in a perforated box, the other in his thermometer-stand. The result of his experiment was that the amount of ozone indicated by the papers placed in the thermometer-stand was more than double of that indicated by the papers in the perforated box (*Proc. Met. Soc.*, vol. i, p. 307).

3rd. There appears to be no uniform time during which the papers are exposed. One observer changes his papers every twelve hours; another, every twenty-four hours. Now the amount of ozone found by the one observer will differ very considerably from that found by the other. Here, then, is another fertile source of error.

I believe that if observers would all employ test-papers of a uniform quality, expose them in the same way, and for the same time, many of the discrepancies at present so apparent in the registration of ozone would be found to disappear.

At any rate, the experiment is worth trying, and if ten or twelve observers, in different parts of England, would kindly forward me the result of their observations, conducted on the following plan, for, say a period of three months, I should be much obliged:—

Let the test-papers used be Schönbein's, as sold by Cassella; let them be exposed in Sir James Clarke's ozone cage, and let them be changed every twelve hours, at say 9 a.m. and 9 p.m.—I am, &c.,

R. C. C. LIPPINCOTT, F.M.S.

Over Court, near Bristol, Oct. 19, 1868.

MISCELLANEOUS.

Embalming.—A subject treated by the patented carbolic acid process of Professor Seely 103 days previously, was recently examined at the Bellevue Hospital by a number of scientific gentlemen, and found in perfect preservation. There was no smell, and the face was startling in its naturalness. The Professor was himself astonished to find that the success of the process was so complete. Decomposition had been absolutely prevented. In this case a simple solution of the acid was applied externally, and injected into the natural openings of the cavities of the body. It is, however, proposed, when there are no objections to making incisions, to inject it also into the veins. It is believed that thus prepared, the bodies will last a hundred years.

Dr. Odling's Manual of Chemistry.—In the autumn will be published, in octavo, “A Manual of Chemistry, Descriptive and Theoretical.” Part II. By William Odling, M.B., F.R.S., Fellow of the Royal College of Physicians, and Lecturer on Chemistry at St. Bartholomew's Hospital. The second part, now announced, will include an account of carbon, with its methylic, formic, and cyanic compounds; also of silicon, boron, and the monad, dyad, and triad metals, with their principal salts.

St. Mary's Hospital.—Dr. Russell has been appointed Professor of Chemistry in this hospital, in the place of Dr. Matthiessen, who is going to St. Bartholomew's.

The Sale of Poisons.—Among the statutes which received the Royal assent on the day of the prorogation was one to regulate the sale of poisons, and to alter and extend the Pharmacy Act, 1852. The preamble declares it to be expedient, for the safety of the public, that persons keeping open shop for the retailing, dispensing or compounding of poisons, and persons known as chemists and druggists, should possess a competent practical knowledge of their business;

and to that end, from and after the day named in the Act, all persons not already engaged in such business should, before commencing such business, be duly examined as to their practical knowledge, and that a register should be kept; and also that the Pharmacy Act, the 15th and 16th of Victoria, cap. 56, should be amended. From and after the 31st of December next persons selling or compounding poisons, or assuming the title of chemists and druggists, must be registered unless they are pharmaceutical chemists, and must conform to such regulations as to the keeping, dispensing, and selling of such poisons as may from time to time be prescribed by the Pharmaceutical Society, with the consent of the Privy Council. Certain articles mentioned in a schedule annexed to the Act are stated to be poisons, and other articles may be declared to be within the category. Chemists and druggists within the meaning of the Act to consist of all persons who at any time before its passing had carried on in Great Britain the business of a chemist and druggist, in the keeping of open shop; and also of all assistants and associates who before the passing of the Act were registered under the Pharmacy Act, and also all persons as may be registered under the present Act. With the view of protecting the public it is now provided that any person who at the time of the passing of the Act was of full age, and can produce to the Registrar of the Pharmaceutical Society by the 31st of December next, certificates as set forth in the schedule that he had been for a period of not less than three years actually engaged and employed in the dispensing and compounding of prescriptions as an assistant to a pharmaceutical chemist or to a chemist and druggist as defined by the Act, is on passing such a modified examination as the Council of the Pharmaceutical Society, with the consent of the Privy Council, may declare to be sufficient evidence of his skill and competency to conduct the business of a chemist and druggist, be registered as a chemist and druggist under this Act. Those entitled to be registered at the passing of the Act are to be registered without the payment of a fee. The examiners under the Pharmacy Act are to be the examiners under the present one, and the Registrar under the Pharmacy Act to act under this statute. The Council of the Pharmaceutical Society are to make orders for regulating the register to be kept. Every Registrar of deaths in Great Britain is required to give notice of the death of a chemist. The evidence of qualification of persons to be registered is to be given to the Registrar, and any appeal from his decision to be to the Council of the Pharmaceutical Society. An annual register is to be kept. Restrictions as to the sale of poisons to be subject to penalties. No poisons are to be sold either by wholesale or retail unless labelled, and poisons are not to be sold to any person unknown to the seller unless introduced by some person known to him, and before the delivery an entry is to be made in a book, and the signature of the purchaser attached, under a penalty of £5 for the first offence. Persons registered under "The Medical Act" are not to be registered under this Act. The Adulteration of Food Act is to extend to medicines. From the passing of the Act all powers vested in the Secretary of State by the Pharmacy Act are to vest in the Privy Council, and power is given to the Privy Council to erase the names of persons from the register. The statute, which is not to extend to Ireland, is to be cited as "The Pharmacy Act, 1868."

Secure Cement for Envelopes.—The editor of the *Practical Mechanics' Journal* says that the thick glutinous juice which is found in considerable quantities in the interior folds of the leaves of the New Zealand flax (*Phormium tenax*), and which is, in fact, a sort of hemp in natural solution, possesses the properties desired. While liquid it can be used as common gum; but once dry, no ordinary solvent has any action upon it. This natural product might be collected, and probably without prohibitory expense and in sufficient abundance, as the *Phormium* is a New Zealand weed, covering whole square miles. It is still open to experiment for the colonists there to add this to their produce, and it is for some

of our Waterlows or Spottiswoodes to initiate it, by getting to England such a first supply of the juice as would enable our chemists to examine its precise nature, and to assign the conditions for, and limitations to, its use for envelopes. It is said that silk dissolved in chloride of zinc affords another sort of liquid cement presenting some, at least, of the characters here needed; but it has others which are objectionable, in tending to destroy in time the paper. Again, it is stated that a solution of pure woody fibre in ammonio-chloride of copper embraces the requisite properties. Dr. Scoffern has, the writer believes, experimented a good deal upon this and other uses for this very singular compound, but he is not aware how far it has been found suited to closing envelopes. He does not anticipate well of it in some respects, and those the same as render the silk objectionable.

Death of Persoz.—With regret we announce the death of Monsieur Jean François Persoz, Officier de la Légion d'honneur, Professeur au Conservatoire des Arts et Métiers, Directeur de la Condition des Soies et des Laines de Paris, Membre du Conseil d'Hygiène et de Salubrité publique. He died at Paris on Saturday last, September 12th. His loss will be mourned by a large circle of relatives and scientific friends.

Manufacture of Aniline Dyes.—Messrs. Nicholson, Maule, and Co., the well-known manufacturers of the aniline dyes, have relinquished business in favor of Messrs. Brooke, Simpson, and Spiller. As all these gentlemen have for many years been connected with the business, and Mr. Spiller has carried on the management of the laboratory since the introduction of aniline dyes, the high character and uniformity in strength and quality that have always characterised the dyes of the late firm will doubtless remain unimpaired under the management of the present proprietors.

Strychnia in Beer.—The *British Medical Journal* of the 5th Sept. contains the following most improbable statement. It is to be regretted that our contemporary did not give it on better authority than "It is said," or at all events did not publish the names of the several large brewers:—"It is said that several large brewers are experimenting on the properties of strychnia, with a view of testing how far it may be used safely in bitter ales."

Rectifying Alcohol by Means of Gelatine.—Whilst witnessing the manipulations of the Eburneum process in the studio of Mr. Burgess, at Norwich, Mr. Burgess mentioned a curious circumstance. When the gelatine and pigment forming the layer of eburneum is quite dry, it is coated with collodion to render it impervious to moisture. This operation he noticed always rendered the eburneum soft and limp, so that it required placing in the drying-box again. The greediness of the gelatine for moisture causes it to absorb the trace of water in the solvents of the collodion, and so become damp. This suggested to us a possible use for rectifying small quantities of alcohol, or removing water from collodion in which the use of imperfectly-rectified solvents has caused a tendency to give crapy films. Place a little pure gelatine in the spirit to be rectified. There is no danger of any portion of it dissolving, but it will absorb the water and gradually swell; it may then be removed, carrying the water with it. This will be found more convenient than the plan sometimes recommended of agitating with carbonate of potash, and after subsidence decanting.—*Photographic News*.

Disinfection of Streets and Confined Places.—Dr. Whitmore has ordered periodical watering of streets, courts, alleys, and confined places in Marylebone, with disinfecting liquid during the last six weeks. In Paddington, both carbolic acid and Condy's liquid have been lately used for deodorising the sewers and gullies.—*British Medical Journal*.

Schonbein.—Christian Friedrich Schönbein, whose death has been recently announced, was born at Metzingen, in

Württemberg, 18th October, 1799. When quite a young man he lived for some time in England and France. In 1828 he was appointed Professor of Chemistry in the University of Basel. His discovery of ozone took place in 1839, and that of gun cotton and collodion in 1845.

Chemical Prize to be Competed for.—Messrs. Ohlendorff and Co., of Hamburg, offer to pay the sum of £85 or the best experimental and physiological investigation of the prize subject mentioned below, and they invite the German establishments founded for investigating the applicability of artificial manure, as also agricultural chemists, and agriculturists in general, to take interest in this prize subject. The prize will be paid for that treatise which the arbitrators designate as the best of the competing treatises. The treatises must bear a motto, whilst the name of the author is adjoined in a sealed envelope; they are requested to be sent, post-paid, to Professor Dr. F. Schultze, of Rostock, not later than on the 1st of November, 1869. Besides Dr. Schultze, Professor Dr. A. Stöckhardt, of Tharand, and Dr. H. Grouven, of Salzmünde, have consented to serve as arbitrators. The decision of the arbitrators will be published before the end of the year 1869. The successful treatise will be published by Messrs. Ohlendorff. The other better treatises will also be published, if the respective authors will consent. The remaining treatises will be returned post-free. Prize subject—Uric (hippuric) acid and guanine are essential components of the guano from Peru. What is the behaviour of these components in raw guano and in prepared guano, with regard to absorption and diffusion, when acting upon different soils? Do they nourish the plants direct, or do they serve indirectly as sources of ammonia and nitric acid?—Ohlendorff and Co., Manufacturers of Prepared Guano from Peru, authorized for Germany from the Guano Depot, of the Peruvian Government, Hamburg, January 14, 1868.

British Pharmaceutical Conference.—The fifth annual meeting of the conference was held at Norwich during the meeting of the British Association, under the presidency of D. Hanbury, Esq., F.R.S. Many valuable papers were read, for some of which we hope to find space. The exhibition of objects relating to Pharmacy is yearly becoming more important. We regret that pressure on our space forbids our giving a list of the numerous objects exhibited; they were, however, all novelties of great practical interest to the Pharmaceutist. The concluding meeting was held on Tuesday, August 25, at 10 a.m. R. Fitch, Esq., Vice-President, F.S.A., F.G.S., Sheriff of Norwich, in the chair, when it was proposed by Mr. Arnold (Norwich), seconded by Mr. King (Bath), and carried *nem. con.*—"That the meeting of the British Pharmaceutical Conference for 1869 be held at Exeter, concurrently with the meeting of the British Association for the Advancement of Science." The following were balloted for and unanimously elected officers of the Conference for the year 1868-9:—*President*: D. Hanbury, F.R.S., F.L.S., &c., Plough Court, London, E.C. *Vice-Presidents who have filled the office of President*: H. Deane, F.L.S., Clapham Commons, S., Prof. Bentley, F.L.S., M.R.C.S., 17, Bloomsbury Square, London, W.C. *Vice-Presidents*: W. W. Stoddart, F.G.S., Bristol, J. Ince, F.L.S., F.C.S., &c., London, G. Cooper, Exeter, H. S. Evans, F.C.S., London. *Treasurer*: H. B. Brady, F.L.S., F.C.S., Mosley Street, Newcastle-on-Tyne. *General Secretaries*: Prof. Atfield, Ph.D., F.C.S., 17, Bloomsbury Square, London, W.C., R. Reynolds, F.C.S., Commercial Street, Leeds. *Local Secretary*: Mathew Husband, 95, Fore Street, Exeter. *Committee*: J. H. Atherton, F.C.S., Nottingham, J. C. Brough, F.C.S., Kensington, A. J. Caley, Norwich, M. Cartelghe, F.C.S., London, T. B. Groves, F.C.S., Weymouth, J. Palk, Exeter, R. Parkinson, Ph.D., Bradford, G. F. Schacht, Clifton, F. Sutton, F.C.S., Norwich. *Auditors*: E. Arnold, F.C.S., Norwich, G. Cubitt, Norwich. Professor Atfield, on behalf of his brother officers, fellow-members from a distance, and himself, thanked the Vice-President, Local Secretary, members of the Local Committee, and other Norwich members, for the cordiality and large-hearted hos-

pitality with which they had been received. The meeting had been successful from all points of view; the papers had been good and numerous; the discussion on the Pharmacy Act most useful; the exhibition of Pharmaceutical novelties highly interesting. For the first time, in the history of the Conference, local members had invited to their homes, for the whole week, some one or more visitors, treating them with an amount of liberality and friendliness which was scarcely preceded. There was not one of his brother members from London and other towns, but had spoken in highly laudatory terms of the successful efforts of the Norwich members,—efforts which would render pleasantly memorable this 1868 meeting.—Mr. Ince, in eulogistic terms, spoke of the time and labour which must have been expended in making the arrangements which had been so successfully carried out by the local members. The days had been so pleasantly occupied that neither he nor Mrs. Ince had had opportunity to see one-half of the objects of interest at Norwich, and similar remarks had been made by most of his friends.—Mr. Arnold and the Chairman assured the visitors that the Norwich members had derived perhaps more pleasure and profit than they had conveyed, and hoped that future meetings of the Conference would be still more agreeable and useful than the present gathering.

India-Rubber Sponge.—One of the most ingenious and useful applications of india-rubber which we have seen for a long time has been forwarded to us by Messrs. P. B. Cow, Hill, and Co. It consists of a highly porous cellular mass of vulcanised india-rubber. The material is at present only supplied in oblong rectangular tablets stiffened at the back by a plate of solid india-rubber. This renders it more effective for cleaning paint, windows, &c., but somewhat detracts from its use as a substitute for a bath sponge. If the makers would supply the material in oval tablets or larger masses without any solid stiffening it would form a most perfect imitation of sponge, and would have the great advantage of being almost indestructible. It can be used either with or without soap.

To Detect the Presence of Atmospheric Air in Coal Gas.—Dr. T. Werner, at Breslau, recommends for this purpose the use of the following substances:—Ten parts by weight of anhydrous sulphate of protoxide of manganese are put into a two-necked Woulf bottle, and therein dissolved in twenty parts of warm water. To this mixture is immediately added a solution of ten parts by weight of tartrate of potassa and soda (Rochelle salt), dissolved in sixty parts of water; the thorough mixing of the fluids is promoted by well shaking of the bottle, after this there is added a quantity of a solution of caustic potash sufficient to render the fluid quite clear; immediately after this the corks, perforated of course and fitted with very tightly fitting glass tubes, are placed in the necks of the bottle, which should be entirely filled with the mixed fluid just alluded to. One of the glass tubes—the inlet tube for the gas to be tested—should just dip a little under the upper level of the fluid; the outlet tube, on the other hand, should only reach half way the perforation of the cork. A very slow current of gas is now made to pass through the fluid, and kept going for at least a quarter and at most one full hour. In case the gas is quite free from atmospheric air, the fluid in the bottle will remain quite clear; if traces even of air are present, a faint colouration of the liquid will soon become apparent; with a larger proportion of air present in the gas the fluid will soon be rendered first light brown coloured, and afterwards intensely black. Since these changes of colour are due to the oxidation of the salt of manganese, it is evident that every care must be taken to avoid the presence or access of accidental air; the fluid in the Woulf bottle should reach the cork. It is best to cool the bottle during the experiment with ice, if at hand, otherwise with very cold water; the current of gas must be slow.—*Pharmaceutische Zeitschrift für Russland*, 1868, No. 7.

The New Parliament.—There is good reason to hope

that Science will be well represented in the new Parliament, for some of our most eminent chemists and physicists are in the field. Amongst them we may mention Dr. J. H. Gladstone, F.R.S., who is working hard to secure a seat for the city of York; Dr. Lyon Playfair, F.R.S., and Dr. Richardson, F.R.S., are candidates for the university of Edinburgh; while Mr. J. Lowthian Bell is, we hear, aspiring to a seat for Berwick; Alfred Smea, F.R.S., for Rochester; Sir John Lubbock, Bart., F.R.S., for West Kent; and Colonel Sykes, F.R.S., again a candidate for Aberdeen. We studiously avoid political and party questions in this journal, but we cordially wish these eminent candidates success, because the great question of technical education, which has been so freely discussed in our columns, is likely to receive the serious consideration of the reformed parliament, and the greater the number of scientific representatives, the more likely are we to have this momentous subject brought to a satisfactory issue.

Science Teaching in Southampton.—On Thursday afternoon a very interesting experiment was commenced at the Hartley Institution, which may have results of a rather important character in Southampton. The experiment itself was simply the delivery by Dr. Bond, the principal of the institution, of the first lecture of a course on "Experimental Physics," adapted for young persons; but what renders it especially interesting is the fact that the greater part of the audience on the occasion consisted of about 200 boys, who had been selected from the national and other similar schools of the neighbourhood, and who, with their teachers, will be admitted gratuitously to the course. The object which Dr. Bond has in view in making this experiment, which has grown out of a conference with the teachers held a short time ago in the institution, is two-fold—firstly, to prepare a certain number of the boys for the examinations of the Department of Science and Art, and for competition for the Local Science Exhibition, which has lately been founded by the council of the institution, in conjunction with the Lords of the Privy Council, for artisans in Southampton; and secondly, to lay the foundation of a regular system of science teaching in the national schools of this neighbourhood. It is hoped that this will be effected by the opportunity which the masters will have of qualifying themselves by attending the course for obtaining the science certificates of the Department of Science and Art, and thus earning payment for themselves on results. They will also be the better enabled, by having themselves heard the lecture, to prepare the boys in the subjects of each, to facilitate which, at the close of each lecture, a printed syllabus of the ensuing one is distributed at the door. We believe that this is the first occasion on which such an experiment as this has been made, here or elsewhere, and we cannot but think that if it were followed generally in our larger towns the problem of how to introduce science into our artisan schools, in the absence of trained teachers, which now prevails, would be simply and rapidly solved. We may also add that in making the proposal to the teachers to establish this class, Dr. Bond offered to hand over to them all payments which might be made to him by the Department of Science and Art on account of the boys attending the class who might take certificates at the examinations of the Department, on condition that the teachers would undertake to supplement the work of the lecturer by preparing the boys in school for the examination, thus giving the teachers a direct personal interest in the work of the class.

PATENTS.

Communicated by Mr. B. VAUGHAN, F.C.S., Patent Agent, 54, Chancery Lane, W.C.

GRANTS OF PROVISIONAL PROTECTION FOR SIX MONTHS.

2418. J. Heaton, Langley Mills, Derbyshire, "Improvements in the

production of steel and other compounds of iron and carbon resembling steel."—Petition recorded, July 31, 1868.

2725. J. H. Johnson, Lincoln's Inn Fields, "Improvements in the preparation of a blue colour from aniline."—A communication from P. P. Zweifel, Paris.—September 4, 1868.

2923. H. J. B. Kendall, Great Winchester Street, London, "A new or improved preservative paint or composition for protecting ships' bottoms, preserving submarine wood work, and other useful purposes."—A communication from W. F. Babcock, San Francisco, California, U.S.A.—Petition recorded September 23, 1868.

2940. J. Baggs, High Holborn, Middlesex "Improvements in making white lead, and in the means and appliances for performing the same."—September 25, 1868.

2962. G. F. Morant, Frenchay, Gloucestershire, "Improvements in the manufacture of artificial fuel."—September 26, 1868.

2968. C. D. Abel, Southampton Buildings, Chancery Lane, "Improvements in converting cast-iron into wrought iron and in unifying oxides and fluxes with molten cast-iron."—A communication from T. S. Blair, Pittsburg, Penn., U.S.A.—September 28, 1868.

2996. W. E. Newton, Chancery Lane, "Improvements in treating metals for the purpose of separating from them various impurities or foreign substances."—A communication from N. Cutter, Cincinnati, Ohio, U.S.A.

2998. J. H. Johnson, Lincoln's Inn Fields, Middlesex, "Improvements in the manufacture of white lead, and the production of carbonic acid gas for the said manufacture, and for other useful purposes."—A communication from H. Hannen, B. F. Pine, and T. Woods, Philadelphia, Penn., U.S.A.

3004. A. T. Becks, Birmingham, and G. Johnson, Aston, near Birmingham, "Improvements in the manufacture of rouge and polishing powders."—September 30, 1868.

3006. H. Highton, M.A., Brighton, Sussex, "Improvements in the manufacture of artificial stone and slate, and in colouring and preserving the same, part of which are also applicable to the preservation of walls and other surfaces."

3016. W. E. Newton, Chancery Lane, "An improved process for decorticating grain."—A communication from E. Weiss, Rue St. Sebastien, Paris.—October 1, 1868.

3026. C. E. Brooman, Fleet Street, London, "Improvements in the treatment of fatty matters in order to harden them, and apply them to the manufacture of candles, soap, and other uses."—A communication from M. Paraf-Javal, and E. Paraf-Javal, Thann, France.

3034. E. A. Cowper, Great George Street, Westminster, "Improvements in the manufacture of iron and steel, and in the apparatus and materials used for that purpose."—October 3, 1868.

3050. J. G. Willans, St. Stephen's Crescent, Middlesex, "Improvements in the manufacture of iron and steel."—October 6, 1868.

3119. N. Smith, Glasgow, N.B., "Improvements in treating and utilising waste acid liquors."—October 12, 1868.

NOTICES TO PROCEED.

1432. J. Heaton, Langley Mills, Derbyshire, "Improvements in reverberatory and other furnaces."—Petition recorded May 2, 1868.

1470. D. R. Macgregor, and P. Taysen, Leith, Edinburgh, "Improvements in the manufacture of paint for the protection of iron and other metals from the destructive influence of sea water, and for the prevention of fouling."—A communication from H. W. Matzen, Sonderborg Schleswig.—May 5, 1868.

R. Moore, Glasgow, N.B., "Improvements in the manufacture or treatment of crushed sugar."—A communication from C. Spreckles, San Francisco, California.—May 11, 1868.

1579. J. E. Piper, Wilson Street, Finsbury, Middlesex, "A new or improved oil for lubricating machinery."—May 14, 1868.

1602. W. R. Lake, Southampton Buildings, Chancery Lane "An improved mode of embalming or preserving dead bodies."—A communication from C. A. Seeley, C. J. Eames, W. E. C. Clark, and M. L. Booth, New York, U.S.A.—May 15, 1868.

1617. W. E. Gedge, Wellington Street, Strand, Middlesex, "An improved process for extracting or removing wool and hair from hides or skins."—A communication from P. Clérin, Faubourg St. Martin, Paris.—May 16, 1868.

1680. C. Hengst and H. Watson, Fulham, Middlesex, "An improved mode of, and means for, manufacturing gas for lighting and heating purposes."—June 18, 1868.

1922. J. Gray and R. Weir, Glasgow, N.B., "Improvements in treating ores and in refining crude metals, in order to obtain steel, copper, tin, and lead, and in apparatus therefor."—Petition recorded June 12, 1868.

1932. C. Hemfrey, Southwark, Surrey, "Improvement in the preparation of a flexible compound applicable to waterproofing and other purposes."—June 13, 1868.

2123. J. B. Brown, Walker, Northumberland, "Improvements in furnaces for calcining ores and other mineral substances."—July 3, 1868.

2366. F. Lambe, A. C. Sterry, Rotherhithe, Surrey, and J. Fordred, Blackheath, Kent, "Improvements in treating animal and vegetable oils, fats, fatty acids, wax, resins, essential oils, balsams, and the solid and liquid hydrocarbons."—July 27, 1868.

NOTES AND QUERIES.

Claret Colour.—A correspondent asks for a formula for a good claret colour for printing on woollen cloth—a steam colour.

Setting Worsted Tubes.—Will any of your readers have the

ness to inform me of the best method of setting worsted tapes previous to dyeing, to prevent them from doubling up or shrinking when they are boiled in the dye cistern.—K. B. C.

Sulphocyanide of Ammonium.—In Mr. Peter Spence's notice of this substance inserted in your valuable journal of the 4th ult. (*Am. Repr.*, Nov., 1868, 272), he states—"Some twenty years ago it was the custom to saturate the ammoniacal water of the gas manufacture with sulphuric acid, then to evaporate and crystallise." The phrase "to saturate the ammoniacal water of the gas manufacture with sulphuric acid" is as incorrect as statements contained in his paper on the "Smoke Question," which appeared in the *CHEMICAL NEWS* of November 2nd, 1866 (*Eng. Ed.*).—J. C. LEE, Jessamine Villa, Ashton-on-Mersey, near Manchester, Sept. 28th, 1868.

Peaty Soil.—In answer to the query in your journal two weeks ago, respecting certain peaty lands that were ploughed and drained and failed to be productive, notwithstanding a large quantity of organic matter as humus being present; it is too common a mistake that the presence of humic acid makes a soil productive; it has often a tendency to be injurious, by keeping iron in a protoxide state, and locking up some of the other organic constituents in a soil. Indeed this is a question of very great importance, as few can believe the narrow limit that often exists between a productive and unproductive soil. I have had acid soils that a grain or two of mineral alkali to the 1,000 of soil has increased the productiveness from 40 to 50 per cent. Your querist wishes to know what are the elements likely to be exhausted in the peaty soil—ammonia, nitrogen, phosphates, &c.? Without a full analysis of the soil, the kind of manure applied, with the crops taken off, and yield, it is not easy to say what is wrong. It is not likely that any of the substances named are wanting, as phosphates, in all likelihood, would be applied, and rain and snow would give ammonia; ammonia and nitrates, added too freely, would make such a soil unproductive. I have no doubt but were they applying some quicklime, and if, in the neighbourhood of blast furnaces, they were putting a heavy top-dressing of finely-ground slag, the soil will be productive.—A PRACTICAL FARMER.

Fireproof Dresses.—In answer to Mr. Philip Sankey's inquiry in your number of September 11th (*Am. Repr.*, Nov., 1868, page 276) he may receive full particulars of a satisfactory process on writing to, or calling on, J. Versmann, 26 Alfred Street, Bow, London, E.

Adulterated Honey.—According to a short notice in No. 34 of the *Deutsche Industrie Zeitung*, there are at present in Germany itinerant dealers in so-called Swiss land-honey. This substance finds a large number of purchasers, on account of its fine taste and beautiful appearance, while, instead of being real honey, it is simply starch converted into sugar by means of sulphuric acid. It may be detected by means of the presence of sulphuric acid therein—viz., in the shape of sulphate of lime or gypsum; its use, of course, is perfectly harmless, but it is not honey, nor does it contain any at all.—CHEMISTS.

Bleaching and Dyeing Cotton.—On referring to several works on bleaching and dyeing cotton, I do not find any suitable—i.e., on the large scale—practicable method recorded for bleaching cotton in the cop; it has been tried, but with no good result. As to the "fast" green dyes, excepting the Chinese green, lo-kao, and chrome green, all green dyes are compounded from blue and yellow. It would take far too much space to enter into detailed accounts of the various receipts for these dyes, but your correspondent may be referred to the following works:—"A Dictionary of Calico Printing and Dyeing," by Charles O'Neill. London and Manchester: Simpkin and Marshall, & Co. Ireland. 1862.—Johannes Rudolf Wagner, "Hand und Lehrbuch der Technologie." 5 vols. Leipzig, 1862. (Vol. 4 contains the required information).—On Lo-Kao, or Chinese Green, several small pamphlets have been published—viz., by Roudot and Persoz, Paris, 1853; Löffler Das China grün Welmar, 1861.—"A Practical Treatise on Dyeing and Calico Printing." New York: Harper Brothers, 1859.—Lastly, I may quote the yet sound and highly classical work on this subject by J. Persoz, "Traité Théorique et Pratique de l'Impression des Tissus." Paris: Victor Masson, 184; 54 vols., and large quarto atlas with plates. Perhaps there is a second and more recent edition.—A.

Technological Analysis of Water.—The soap-test, though it shows the value of waters for domestic and for certain manufacturing purposes, throws very little light upon their adaptability to the purposes of dyer and printer. Two samples of water of the same degree of hardness may have very different actions upon colouring matters, according as the hardness of the one depends upon lime, and that of the other upon a salt of alumina or of iron. Having been obliged to make very numerous and rapid examinations of river waters contaminated with manufacturing refuse, I have found great advantage in employing an extract of logwood—a reagent readily and distinctly affected by the various impurities likely to be present. I prepare the extract as follows:—Distilled water is digested upon an excess of rasped logwood in a stoppered vessel for twenty-four hours, when the clear liquid is decanted off for use. 4 ozs. of distilled water are then put in a phial of clear white glass, and 100 grs. measures of the logwood extract added. This dilute liquor is of a clear reddish amber colour, and serves as a standard for comparison. 4 ozs. of the sample of water in question are then poured into a phial exactly similar to the above, and the same quantity of logwood extract is added. If the water contain a soluble chloride, the colour given will be yellower than in the case of distilled water. Gypsum, or an alkaline sulphate, will produce a yellow, bordering on olive; alkalies, hydrated or carbonated, will give a brownish red; salts of alumina, a maroon, passing into plum-colour; free acids, a cherry; and salts of iron and chromates a black-brown. Even the quantities of these impurities may be approximately determined by preparing solutions containing known quantities of the various salts above-mentioned, and comparing their action upon the logwood extract with that of the sample in question. Waters holding

solid matter in suspension must, of course, be previously purified by subsidence and filtration.—W.

Lubricating Oils.—A correspondent would be glad to know of the best work on the manufacture or refining of lubricating oils.

Cement Required.—A cement or glue to fix an india-rubber washer to cast iron. Cement or glue must stand boiling water and superheated steam.—A. W. WILSON.

Vegetable Fibre.—A correspondent is particularly anxious to procure samples of a vegetable fibre of great toughness and of good length. Can any reader forward specimens?—W. W. ROBERTS.

Salt of Manganese.—What formula does Rammelsberg ascribe to the red salt of manganese, cyanogen, and potassium, mentioned in the *CHEMICAL NEWS*, vol. IV., page 201 (*Eng. Ed.*), and does any account of these researches exist in English?—Mx.

Phosphoric Acid.—A good method of separating phosphoric acid from bases consists in dissolving the substance to be analysed in a small quantity of nitric acid, and adding to the solution, first nitrate of silver, then carbonate of silver, and well shaking. All the phosphoric acid then combines with the oxide of silver and is precipitated, whilst the bases remain in solution and may be freed from the excess of silver by means of hydrochloric acid.—F. WILKER.

Fire-Proof Dresses.—Some years ago, at the request of the Queen, Dr. Graham, the present Master of the Mint, caused a series of experiments to be instituted by Dr. Versmann, the result of which led to the regular use of a tungstate of soda in the Royal laundry to render ladies' wearing apparel fire-proof. Dr. Versmann published a pamphlet on this subject, giving full instructions as to the use and application of the above-named article (the tungstate of soda), and it is likely that your correspondent, Philip Sankey, can obtain all the particulars from Dr. Versmann. Tungstate of soda, fit for this purpose, is to be had cheaply enough, and its use neither affects the fabrics, nor injures the beauty or colours thereof.—DE. A. A.

Drying Oil.—I want to render unboiled linseed oil a quickly drying oil. I have tried Liebig's plumbic oxide and acetate process, but do not find it do well. Ure's "Dictionary" directs 1,000 of manganous borate to be added, but this does not do with me. I want to do away with the boiling or heating of the oil, and if any of your contributors will kindly give any information I will feel greatly favoured.—WATER-PROOF.

Cashew Nut.—Can any of your readers tell me the composition of the volatile oil, and of the acrid principle in cashew or monkey nuts?—A. L.

Phthalic Acid.—Will any one be kind enough to tell me by what method crude naphthalin can be converted into phthalic acid, and the proportions of ingredients? I know there is a process, but I don't know what it is.—NAPHTHALIN.

Will the Sun put a Fire out?—I am told by many persons, whose powers of observations are trustworthy enough, that the direct rays of the sun will check the flame of a burning fire, and even put it out altogether. I have never noticed the fact myself, but I find it is quite generally believed to be well founded. Has it ever come under scientific observation, and, if so, what is the cause assigned for this remarkable action?—G. L.

[The appearance is due to an optical illusion caused by the great flood of light shining on the coals and ash, and overpowering the feeble light of the flame and red-hot coals.—ED. C. N.]

CONTEMPORARY SCIENTIFIC PRESS.

[Under this heading it is intended to give the titles of all the chemical papers which are published in the principal scientific periodicals of the Continent. Articles which are merely reprints or abstracts of papers already noticed will be omitted. Abstracts of the more important papers here announced will appear in future numbers of the "CHEMICAL NEWS."]

Comptes Rendus. July 6, 1868.

DE LA RIVE, "On the cause of the Intensity of the Magnetic Rotatory Power of Thallic Alcohol." J. JAMIN, "On a Thermo-rheometer." LEAUTE and DENOUE, "On a Lamp for Submarine Operations, fed by Oxygen without Communication from the External Atmosphere." G. LECHARTIER, "A Reproduction of Pyroxenes and Peridots." ROSENTHAL, "On a new Alkaloid, Isomerie with Toluidine, contained in Commercial Aniline." SCHUTTENBERG, "Researches on the Action of Hypochlorous Acid Gas on a Mixture of Iodine and Acetic Anhydride." (Continuation.) C. HESSES, "On the Action of Iodine on Arseniuretted and Antimoniuretted Hydrogen."

July 13, 1868.

C. FRIEDEL, "On Iodide of Silicon and on Siliciodoform."

Bulletin de l'Académie Royale de Belgique. (Classe des Sciences.) June 6, 1868.

L. DE KONINCK and STAS, "Report on L. Henry's Researches on the Sulphocyanides of Organic Radicals." L. HENRY, "Researches on the Sulphocyanides of Organic Radicals: Action of the Hydrogen of the Halogens on the Sulphocyanides of Monatomic Alcohol-Radicals."

Annalen der Chemie und Pharmacie. July 1868.

R. FITTIG and J. STORER, "Researches on Mesitylens." (Second Memoir.) "On some new Substitution Products of Mesitylens." R. FITTIG, "On Pseudocumol and some of its Derivatives." L. FITTIG.

TIG, W. ANDREAS, and L. MATTHEIDES, "On the Xylol of Coal Tar, and on the Synthesis of Methyl-tolual" (Dimethyl-benzol). R. FITTIG, "Note on the Brominated Substitution Products of Toluol." R. FITTIG and W. H. BREUCKNER, "Researches on Mesitylene. (Third Memoir.) On the Derivatives of Mesitylenic Acid." L. GLUTZ, "On Oxymethylene and some of its Derivatives." F. GAUHE, "On Dimethyldibenzol." H. KOLBE and F. GAUHE, "On Nitro-oxymethylene-sulphuric Acid and Dichloroxyphenylsulphuric Acid." K. KRAUT, "On Cinnamic Acid and its Isomer Atropic Acid. (First Memoir.)" A. CLAUDE, "On the Decomposition of Grape Sugar in Alkaline Solutions by Oxide of Copper: Formation of Oxymalonic Acid (Tartronic Acid)." L. CAHUS, "On Propylphosphite and on Claus's Experiments with the same."

Annales de Chimie et de Physique. July, 1868.

L. CAHILLIET, "On the Influence of Coloured Light on the Decomposition of Carbonic Acid by Plants." E. FILHOL, "On Chlorophyll." J. KOLB, "Researches on Bleaching Fabrics."

Kunst und Gewerbeblatt. April, 1868.

N. STANGE and A. SPARKOWSKY, "An Improved Apparatus for Burning Petroleum and other Fluid Hydrocarbons in the Form of Spray." C. STOLZEL, "A Method of Coating Iron and Steel with Copper."

May, 1868.

S. MEYER, "Researches on the Optical Properties of Flint Glass." BOTTGER, "On a Fluid for Coating Copper, Brass, and German Silver, &c., with Platinum. On a Method of Preparing Zinc to receive a Coat of Paint."

Journal des Fabricants de Papier. May 15, 1868.

"On the Manufacture of Filter Paper."

July 20, 1868.

SIDOT, "Researches on the Magnetic Polarity of Artificially-prepared Iron Pyrites, and of the Corresponding Oxide." P. SCHUTZENBERGER, "On the Colouring Matters of Persian Berries."

Monatsbericht der Königlich Preussischen Akademie der Wissenschaften zu Berlin. April, 1868.

G. VOM RATH, "On a new Crystalline Modification of Silicic Acid." RAMELBERG, "On the Constitution of the Periodates." A. W. HOFMANN, "On Menaphthylamine."

Poggendorff's Annalen der Physik. June 9, 1868.

T. PETERSEN, "Analyses of Minerals from Wittichen, Baden." H. VOGEL, "A new Photometer for Determining the Chemical Action of Light."

Bulletin de la Société Chimique de Paris. July, 1868.

BERTHELOT, "Note on an Error in the Author and Jungfleisch's Researches on Perchlorinated Benzene, Perchlorinated Naphthalene, and Jullin's Chloride of Carbon." E. BOURGOIN, "On the Electrolysis of Oxalic Acid." J. JOFFRE, "An Analysis of some Bituminous Schists from Scotland." P. AUDOUIN, "A Process for Extracting Ammonia from Gas Liquor."

Journal für Praktische Chemie. No. 12. 1868.

J. L. W. THUDICUM, "Chemical Researches on the Colouring Matters of Bile." E. CARRELLA, "Contributions to the Elementary Analysis of Nitrogenous Substances."

July, 1868.

H. SALKOWSKI, "On some new Arsenates, and on a new Method of Estimating Bismuth." H. ZSCHIESCHE, "On the Atomic Weight of Lanthanum." G. WERTHER, "Remarks on the Isomorphism of Potassium, Thallium, Cesium, and Rubidium." R. HERMANN, "On Granatine and Achatragdite, two new Minerals from Siberia." G. LEUCHE, "On the Presence of Iodine and Soluble Salts in the Dust of the Gases evolved from Blast Furnaces." E. RICHTER, "Researches on the Causes of the Refractory Qualities of Clay."

Archives des Sciences. July 15, 1868.

W. SIEMENS and HALLSKE, "An Improved Apparatus for Measuring the Flow of Alcoholic Liquids and for Indicating the Quantity of Absolute Alcohol contained therein."

Bulletin de la Société Industrielle de Mulhouse. April, 1868.

J. KOLB, "Researches on Chloride of Lime, serving as an Introduction to a Memoir on the Use of that Substance for Bleaching Fabrics."

May, 1868.

A. SCHREUER-KESTNER, "Researches on the Combustion of Coal." WEIER, "Report on E. Burnat's Building Boxes for Birds." SAGEBIEN, "On a new Waterwheel." J. STEIGFRIED, "Report on J. Dollfus' Paper on the Results of the Cultivation of Cotton in Algeria." A. SCHREUER-KESTNER, "Historical Note on the Methods employed for obtaining Sulphur from Soda Waste." "Résumé of the Author's Memoir on the Combustion of Coal." "Memoir on the Composition of the Gaseous Products of Steam Boiler Furnaces." J. ROTH, "On the Use of the Yolk of Eggs for the Preparation of Chocolate and for the Manufacture of an Article of Food."

Supplement. May, 1868.

M. PARAF-JAVAT, "Note on a Method of Facilitating the Process of Printing Calico with Aniline Black." C. F. A. G. WEISE, "An Improved Dye Beck." F. DUPOURC, "On 'Nimrif' and 'Elram,' Two New Colouring Matters from Algeria." COUPPIER, "On the Preparation of Aniline and Toluidine Red without the Use of Ar-

senic Acid." H. KÖCHLIN, "On the Colouring Matter extracted from Soga Bark."

June, 1868.

C. DOLIFUS-GALLINE, "On M. Paraf-Javat's Method of Facilitating the Process of Printing Calico with Aniline Black."

Comptes Rendus. July 27, 1868.

BERTHELOT, "On the Transformation of Marsh Gas into more condensed Carbides." O. LORY, "A Method of Estimating Carbonic Acid in Bicarbonates and in Water." V. DE LUYNE, "On the Colouring Matters derived from Orcine."

August 3, 1868.

P. DESAINS, "Researches on the Obscure Calorific Rays of the Spectrum." TREVES, "On the Development of Magnetism by Induction in Steel Bars." A. BOBRIERE, "On a Remarkable Case of the Transport of Metals by Atmospheric Electricity." BERTHELOT, "On the Hydrides of the Carbides of Hydrogen. Styrolene Series. Part I." A. DESCAMPS, "On the Double Cyanides analogous to the Ferrocyanides and Ferricyanides." J. LEFORT, "Some new Observations on the colouring Matters of Persian Berries."

August 10, 1868.

CHEVREUL, "Report to the Minister of Public Instruction on the Course of Lectures on Applied Organic Chemistry delivered at the Museum of Natural History during the Year 1867." A. SECCHI, "On Stellar Spectra." TOSKELL, "An Improved Method of Manufacturing Large Blocks of Ice." BERTHELOT, "On the Hydrides of the Carbides of Hydrogen. Styrolene Series. Part II. (Conclusion.)" A. ROSENSTIEHL, "On the Detection of aniline, pseudo-toluidine, and toluidine." MEHAY, "On the Condition of Salts in Solutions."

Annalen der Chemie und Pharmacie. August, 1868.

G. STALMANN, "Researches on some Salts of Natural and Artificial Valeric Acid." M. THEILKUH, "On Methylnitrosulphonic Acid, the First Term of a New Series of Acids." F. ILSE, "On Amylenedisulphonic Acid." T. WILM and G. WISCH, "Experiments with Phosgene and Phosgenic Ether." "On the Action of Aniline on Chloro-Carbonic Ether." R. OTTO and G. MORIER, "On Mercury-Naphthyl, and on some Derivatives of Naphthalene." R. OTTO, "Note on the Reduction of Hyposulphuric acid to Sulphurous Acid by Nascent Hydrogen." W. HINTE, "On the Constitution of Diglycolic Acid, and on a new Method of forming Diglycolic Ether." C. SCHOLLEMMER, "Contributions to the Knowledge of the Hydrocarbons of the Series, C_nH_{2n+2} ." "On the Caprylic Alcohol obtained from Castor Oil." O. HESSE, "Contributions to the Chemistry of the Quinine Bases." E. VON GORUP-BESANZ, "On the Synthesis of Oil of Guaiacum Resin."

Journal für Praktische Chemie. July, 1868.

J. L. W. THUDICUM, "Chemical Researches on the Colouring Matters of Urine: On Uromelanine, a Decomposition-Product of Urochrome." E. REICHARDT, "On Mercurialine, an Alkaloid obtained from Mercurialis Annuua." F. VON KOBELL, "On the Detection of Nickel and Cobalt in Ores, and on a Specimen of Chathamite from Andreasberg in the Harz."

Bulletin de la Société Chimique de Paris. August, 1868.

B. TOLLENS and R. WEBER, "On Formiate of Allyl." T. L. PHIPSON, "On the Analysis of a Biliary Calculus, and on the Preparation of Biliocidine." CHEVALER, "On the Estimation of Carbonates in Aqueous Solutions." P. P. DEHERAIN, "Experimental Researches on the Use of Potash Salts in Agriculture made during the year, 1867." A. SCHREUER-KESTNER, "Researches on the Combustion of Coal." A. SCHREUER-KESTNER and O. MEUNIER, "Analysis of the Gases produced during the Combustion of Coal from Saarbrück." E. BOURGOIN, "On the Identity of Dimethyl with Hydride of Ethylene." H. BAUBIGNY, "On the Preparation of Camphoric Acid."

Bulletin de la Société d'Encouragement. May, 1868.

H. BOUILLET, "Report on J. Feugère's Processes for the Electrodeposition of Iron and Tin." BALLARD, "On E. Carré's New Sulphate of Copper Battery." "On E. Carré's New Regulator for the Electric Light."

June, 1868.

MOLL, "Report on De Legarde's Work on the Utilisation of certain Products as Manure." CHEVALIER, "On the Explosive Properties of Mittenazey's Artificial Siffron." DE LUYNE, "On Dubrunfaut's Method of Separating Salts from Molasses and Saccharine Solutions." DUMAS, "On the same Subject." "On Hülfriegel's Experiments on the Fertilising Properties of Manures containing a varying Quantity of Phosphates, Nitric Acid, and Potash." "On Klein's Method of Depositing Iron by Voltaic Electricity."

July, 1868.

PATY, "On Champonnois' new Method of Extracting Sugar." F. P. LE ROUX, "Experiments on the Production of the Electric Light."

Dingler's Polytechnisches Journal. August, 1868.

"On the Extraction of Silver from Lead by means of Zinc in the Upper Harz." H. GRUNBERG, "On the Extraction of Sulphate of Magnesia from the Impure Rocksalt of Stassfurt." E. F. ANTHON, "Contributions to the Knowledge of the Manufacture of Sugar: 6. An instructive Example of Diffusion. 8. On the Errors in the present Methods of Expressing the Results of an Analysis of Sac-

Refining Raw Sugar without the Aid of Heat or Chemicals. 11. *On the Formation of Oxalate of Lime during the Manufacture of Beet-root Sugar.* A. SPIKE, "On Extract of Malder, and on the charine Products." 9. *On the Specific Gravity of a Saturated Solution of Sugar at 14° R.* 10. *An Attempt to Devise a Process for Use of the same in Printing Fabrics.* "On the Preparation of Aniline Black for Printing Fabrics."

ANSWERS TO CORRESPONDENTS.

NOTICE.—The American Publishers of THE CHEMICAL NEWS give notice that in accordance with a suggestion of Mr. Crookes, the Editor and Proprietor of the English publication, they will be pleased to receive and forward to him in London any scientific publications issued in America, for review—and also any Notes and Queries, Articles, Correspondence, etc., for publication or reply. Their facilities of communication with Mr. Crookes render this very desirable to all persons in the United States who wish to confer with him. Address,

W. A. TOWNSEND & ADAMS,
434 Broome Street, New York.

W. M. B.—We should recommend Baerman's work on "Iron Manufacture," recently reviewed in our columns. In a few months the English adaptation of Keri's "Metallurgy of Iron and Steel" will be published.

L. Lawson.—Add strychnine to iodide of methyl. This will readily yield the iodide of methyl-strychnine, and from this the sulphate can be easily prepared.

Theo. J. Schuster, Philadelphia.—The patent is not yet out; a very good article may be made by adding carbolic acid to ordinary soap, slightly increasing the quantity of alkali, if necessary, to dissolve the acid. You will find Remann's "Handbook of Aniline" (published in America by Wiley and Son, of New York), give you the fullest information on the subject of the aniline dyes. There is a German periodical devoted to the subject of dyeing, but not one in English.

A Subscriber.—Dissolve the coin in nitric acid, evaporate the solution to dryness, and fuse the mixed nitrates of silver and copper in a porcelain dish over a lamp until the nitrate of copper is all decomposed. Then dissolve in water, filter, and crystallise.

S. A. S.—Dr. Hassall published a book some years ago on the subject of the "Detection of adulterations in articles of food."

Reader.—You have omitted something in the question. You cannot make sulphate of silver by precipitating nitro-sulphuric acid with dry sulphate of soda.

Berlin Black.—A correspondent asks how to make Berlin black for fire-bricks.

O. Meynott Tidy, M.B., M.A.—The secretary did not reply to our circular, so we were not aware of your being joint lecturer on chemistry with Dr. Letheby.

E. E.—A basic salt is one which contains more equivalents of the base, and an acid salt more equivalents of the acid than are required to form a neutral salt. Thus basic acetate of lead is acetate of lead containing an excess of the metallic base.

Hopeful.—Write to the Registrar, 17 Savile Row, London, W.

H. H. Bonell.—When the manuscript is ready we shall be happy to give advice on the subject.

Apparatus.—"Index," who asked a question on this subject some weeks ago, is referred to 44, Berner Street, where he may probably meet with what he seeks.

W. C.—Eliot and Storer's Inorganic Chemistry. Published by Van Nostrand.

J. A. Wanklyn—E. T. Chapman.—Surely these pertinacious gentlemen must see the absurdity of expecting an Editor to insert a series of letters in reply to a review. We must of course decline to print a second, and we do so with the less regret because we do not perceive that the letter in question adds anything to the real history of the case. In coming to this decision, we have been influenced neither by the insulting remarks in the letter which accompanied the communication, nor by apprehension of the dreadful consequences which are to follow this refusal. The answers which our correspondents make to our strictures appear to us to be nothing but verbal quibbles, and are entirely unsatisfactory.

A. H. Smith.—No good would be gained by publishing your remarks on the process. If you read the review you will see that our opinions are about as favourable as your own.

Fair Play.—Read the review again, and you will see that it is a remarkably favourable one. Then read the book and you will be able to judge how lenient we have been to its many faults.

Carbon.—To answer your question would fill a number. The records of the patent office will supply you with almost any number of apparatus for the manufacture. There is a good demand for bisulphide of carbon, but the price is so low as to be barely remunerative unless other manufactures are united with it.

E. K.—The most philosophical work which has yet appeared on the subject is Professor Wurtz's "Introduction to Chemical Philosophy," published at our office.

A Notice.—Sulphate of silver may be made by mixing together hot strong solutions of sulphate of soda and nitrate of silver. The sulphate of silver precipitates in brilliantly white crystals. Another way to

prepare sulphate of silver is to dissolve silver in hot sulphuric acid. The resulting salt must be purified by washing and crystallisation.

J. E. Wright—The Comptes Rendus are published weekly by Gauthier-Villars, Quai des Augustins, 55, Paris.

Chemists.—Chlorhydric acid is the same as hydrochloric acid. Oleic acid can be purchased at an operative chemist's. Naphthalene yellow, known also as Manchester yellow, is made by Roberts, Dale, and Co., Manchester.

Robinson, Brothers.—Many attempts were made to ascertain the relation between the light emitted by the parliamentary standard sperm candle and that given by the new standard lamp described in No. 450 of the CHEMICAL NEWS (*Am. Repr.*, Sept. 1868, pp. 124, 125); but the variations in the candle light were found to be so great under different circumstances that no satisfactory data could be obtained, and it was therefore thought better to give no result at all, but to leave this comparison to persons who were in the daily habit of using the standard candle, and might be supposed to know the best way to get a uniform light from it.

A. Y. Z.—The process is not practically applied. It succeeds very well in the laboratory; but carried out on a large scale it is a failure.

W. W. W.—Our publisher will forward the CHEMICAL NEWS if you will send a proper address.

J. Horsley.—Our correspondent's letter was received; but as it related almost entirely to controversial matters respecting priority of an invention, we considered it was not adapted to our pages.

J. H. W.—Much of the misunderstanding which exists at present amongst theoretical chemists arises from the confusion of terms. You will do more good to the cause which you wish to advocate by refraining from making public your views on atomistic. This term is generally used in quite another sense from the one in which you apply it.

Chemists.—An aqueous solution of platinum-chloride of potassium constitutes a very good reagent for thallium in dilute solutions. Collect the precipitate and test it in the spectroscopic. Rubidium and cesium will be precipitated at the same time if present.

D. M. W.—1. We are not aware that solutions to the question have been published. 2. The author named has not written a book on "Practical Chemistry." See Professor Bixham's "Chemistry."

J. C. Lee.—We are much obliged for the communication, and will take notice of the subject next week.

J. T.—Declined, with thanks.

W. Simpkin.—The best lubricator you can employ is a mixture of plumbeo and tallow.

M. M. S.—Soak the sections of bone in caustic potash; this will remove the organic matter. Then wash well, and mount in Canada balsam.

Communications have been received from Messrs. Wanklyn and Chapman (with enclosure); W. Leslie; H. Tate; J. Dixon; Gehe and Co., Dresden (with enclosure); E. Kernan; W. E. Buckhurst; H. Corry; R. H. Rowell; E. Ellick; S. Mellor; W. Howell; J. Wilson; Professor Maynard; F. Field; Keynell and Son; D. Forbes, F.R.S.; E. Spiller, Jun.; Longmans, Green and Co.; Dr. Bingley (with enclosure); C. H. Hutchinson (with enclosure); Harvey and Keynolds; T. Comber; C. L. Colthouse; A. Smith; T. F. Miller (with enclosure); W. Hall; G. W. Robinson (with enclosure); Dr. S. Muspratt; Archibald Walker and Co.; G. Greville Williams, F.R.S.; Muspratt, Bros.; and Hunter; G. Jarman; C. M. Tidy, M.B., M.A. (with enclosure); W. Hunter; Williams and Norgate; C. R. A. Wright; Mitchell and Co.; G. Evett; F. Lennan (with enclosure); and J. C. and J. Field; Messrs. Wanklyn and Chapman; Dr. Apjohn (with enclosure); P. Holland (with enclosure); W. J. Bush (with enclosure); W. Little (with enclosure); T. N. Hutchinson; A. H. Smith; P. LeNeve Foster; M. G. Meinhard; W. B. Giles; A. W. Wilson; W. W. Roberts; D. Forbes, F.R.S.; J. Spiller; Dr. K. Angus Smith, F.R.S.; G. F. Rodwell; D. Faulkner; Dr. Wood (with enclosure); R. Richter; A. Yach (with enclosure); H. D. Turner; T. Watts; C. Becker; Dr. Bingley (with enclosure); J. C. Wilson; Motershead and Co. (with enclosure); J. Hulle (with enclosure); Messrs. Brooke, Simpson, and Spiller; Dr. Adriani; Dr. J. H. Gladstone, F.R.S.; D. Forbes, F.R.S.; Dr. F. C. Calvert, F.C.S.; Messrs. Roberts, Dale, and Co.; Dr. R. A. Smith, F.R.S.; J. E. Wright; Robinson, Brothers; T. J. Blunt; E. Bird; W. L. Lewis; C. C. Watkins; J. Kenyon; J. Y. Buchanan (with enclosure); MacLachlan and Stewart (with enclosure); Ludwig Mond (with enclosure); R. Warrington (with enclosure); G. F. Rodwell; Dr. T. Wood; F. Tibbs; S. W. Rich; and Dr. Watts; H. W. Wilson; J. Spicer (with enclosure); The Secretary of the Rivers Commission; D. Forbes, F.R.S.; E. J. Gilpin; Dr. S. Muspratt; J. Horsley; Dr. Rohrig; Messrs. Brooke, Simpson, and Spiller; Gossage and Sons; J. How; MacLachlan and Stewart; J. Woodcock; F. Herpath; F. A. Favel; Marshall Hall; D. M. Edwards; W. W. Smyth (with enclosure); J. C. Lee; A. Liversidge; B. Sulman; A. E. Schmerzahl and Co.; G. Guichenot; Dr. Rohrig; H. H. Watson; Dr. Muspratt (with enclosure); Dr. Odling, F.R.S.; Dr. K. Angus Smith, F.R.S.; J. C. Brown; and Dr. Oxland.

Books Received.—Thorley's Illustrated Farmer's Almanack and Diary for 1869. "A Practical Guide for the Perfumer." Edited from Notes and Documents of Messrs. Debay, Lonel, &c., with additions by Professor H. Dussane. "On the Chemistry of some Carboniferous and Old Red Sandstones." By J. Wallace Young. "On a Simple Method of Exhibiting the Combination of Rectangular Vibrations." By W. Fletcher Barrett. "The British Army in 1868." By Sir Charles E. Trevelyan, K.C.B. London: Longmans. "Notes on Metals, being a Second Series of Notes for the Lecture Room." By Thomas Wood, Ph.D., F.R.S. London: Longmans. "An Introductory Address delivered at the Westminster Hospital." By Francis Mason, F.R.S. London: John Churchill and Sons. "Chemistry for Students." By Alexander W. Williamson, F.R.S., F.C.S., &c. New Edition. London: Macmillan. "The World of Wonders." Part I. London: Cassell, Petter and Galpin.

AMERICAN SUPPLEMENT.

New York, December, 1868.

Greeting.

THE SUPPLEMENT is intended to be made up of chemical news which it is impracticable to obtain by way of England, and will be limited almost exclusively to American affairs. The space allowed for it is too narrow for exhaustive histories of events; there will be

no monographs, disquisitions, or lectures. We make a record of all important American contributions to chemical science, but the record must be made up of brief abstracts and references to the original details may be found. America, it must be said, notwithstanding its wide domain, its constitutional importance, and its eminence in the world, contributes very little to the progress of chemistry, and our space is ample for the condensed record we look for a different state of things when our young men now crowding our scientific halls have come on the stage.

The programme of the SUPPLEMENT, which is the result of considerable thought and advisement, is briefly

to select from the most noteworthy papers in the repertoire who nowadays have so much to occupy them, to esteem it a favor to be advised in advance of the considered fittest to be studied or read. We have decided that such advice is generally acceptable, and it will be never so wise.

Page 1. Abstracts of papers, condensed accounts of discoveries, theories, &c.

Page 2. Information concerning American patents in the chemical arts; this something, however, to be different from that which appears in the present issue.

Page 3. Catalogue of scientific books. To this department we have given such attention that we may have here a current catalogue of all books pertaining to chemistry and the physical sciences printed in America.

Personal notices of practical and professional chemists and physicists, items of news, of fact and theory which can be expressed in a sentence or two.

Trade movements, comprising a complete price-current of chemical's and drugs.

Brief answers to correspondents; notes and queries.

In the narrow space which is allowed us we cannot expect in every number to present matter under all these titles, and shall therefore use the programme only as a proper and convenient classification of the subject-matter of the SUPPLEMENT.

To carry out our wishes and intentions, we need and confidently solicit the kind assistance of men of science, publishers, manufacturers, and merchants. We do not expect to find any one who will be unwilling to favor the generous enterprise of the publishers.

Nitroglycerine.

NITROGLYCERINE disasters have become so frequent that they get as little attention from newspapers as boiler explosions or revolutions in South America. We are informed by telegraph how many pounds of nitroglycerine were exploded, how much property in dollars was destroyed, and how many lives were lost—and that is all. Some people seem to consider that nitroglycerine disasters are inevitable, and, like the lightning stroke, are acts of God from which we may try in vain to escape. There are others, however, who hope through balancing facts and reasons, they may discover the causes direct and remote of the danger from nitroglycerine, and therefrom be able conclusively to determine whether the monster can be tamed or must be kept out of existence. For the benefit of these latter we have been at some pains to procure information about an explosion of 2,000 lbs. of nitroglycerine which occurred in Ohio about the 1st of October.

The nitroglycerine in question was manufactured by the U. S. Blasting Oil Co., at their factory in New Jersey, and was sold and transported during 1867 to the Iron Mountain Railroad Co. of Missouri. It was the intention of the Company to use it in their own work of rock cutting and tunnelling, but becoming afraid of it, or for some other good reason, it remained intact. In Sept. 1868, it was re-sold to the Blasting Oil Co., and was on its way east by railroad, via St. Louis, when it exploded. The explosion occurred on the Atlantic and Great Western Railway, eight miles east of Urbana, O. The nitroglycerine was in the car next to the locomotive and tender, and behind this car were nine others, freighted with pork and flour. The force of the explosion was manifested in the entire destruction of the train by the first shock and the conflagration which ensued, in the demolition of the nearest house, a quarter of a mile distant, the breaking of windows in Urbana which looked to the west, and a sound which was heard at a distance of thirty miles.

The nitroglycerine was contained in tin boxes or cans, each having about one hundred pounds. Each can was enclosed in a wood box; between the can and box on all sides was a layer of dry plaster-of-Paris, about two inches in thickness, the plaster serving as a cushion to relieve any violence in handling, and as an absorbent in case of leakage. This method of packing is covered by a patent, and is prescribed under heavy penalties by an act of Congress.

In this case as in most others no ordinary immediate or sufficient cause of the explosion is apparent. The boxes had endured the heat of summer and the shocks of 2,000 miles of railroad travel; there was no incendiary and no other incendiary material on the train. The boxes were so well protected by the non-conducting plaster, that they might have been thrown on a fire and the wood consumed before the contents of the cans should be warmed. Thus to many there is a hopeless mystery.

A comparison of this with former disastrous explosions shows a coincidence in two particulars which is perhaps worthy of notice, and which we do not remember to have seen pointed out: 1st. The nitroglycerine was prepared by Mr. Nobel or by his licensees, who were instructed by him. 2d. It had been prepared and carefully packed for months prior to the explosion. To the suggestion or imputation of ignorance or unskillfulness which attaches to the first, it may be remarked that Mr. Nobel and his licensees are the only

manufacturers who have transported nitroglycerine in large quantities, and on the other hand, that those who manufacture and use nitroglycerine outside of the patent greatly outnumber the operators under the patent. The second point of coincidence suggests that Nobel's nitroglycerine undergoes a change after its manufacture.

But there are those, and we are among them, who believe they have a reasonable clew to all the mystery of nitroglycerine; this clew they find in its chemical nature. Nitroglycerine is a sort of gunpowder, in which three atoms of the monatomic radical, nitryl (NO_2) serves as the nitre, and the glycerin residue ($\text{C}_3\text{H}_5\text{O}_3$) as the combustible part. The radical NO_2 is a remarkably concentrated and powerful oxidizer, and thus gives to the organic compounds in which it has a place a character of instability and danger. In pure nitroglycerine $\text{C}_3\text{H}_5(\text{NO}_2)_3$, the oxygen is brought very near to its antagonistic elements, and needs but little to provoke a contest which may terminate in an instant or be prolonged indefinitely; but the contest once begun it is irrepressible, unless by some outside interference. The possible products of a slow internal oxidation are numerous, and it is pretty certain that some of these products are more unstable than the nitroglycerine itself. The oxidation is of course accompanied by heat, and if this heat be retained the rate of oxidation will be increased, and the exploding temperature will at last be reached. In short, here is a case of spontaneous combustion, which differs from ordinary cases in the fact that NO_2 takes the place of air. Thus on theoretical grounds the character of nitroglycerine may be predicted.

All such considerations of theory are confirmed by actual experience. Indeed, before the theory was possible we had the facts. Sombrero, de Vrij, Frankland, and other investigators of nitroglycerine, more than twenty years ago, exhibited all its dangerous properties. That it is liable to a dangerously spontaneous change is susceptible of simple and complete demonstration, and no one who will witness it without prejudice can fail to find a satisfactory explanation of the mystery of nitroglycerine.

There are two facts which it is especially desirable to remember: 1st. The spontaneous change once begun in simple nitroglycerine will inevitably terminate in explosion, if the heat of oxidation be confined. 2d. Changed or impure nitroglycerine will explode at lower temperatures and with less force of concussion than pure nitroglycerine. Yet it has been persistently declared that commercial nitroglycerine is not at all liable to spontaneous change, that it will not explode by a heat of less than 360 deg. Fahr., and only by an extraordinary concussion. Pretty successful attempts were made in nearly all the cases of disasters which were judicially investigated to divert attention from the dangerous character of nitroglycerine by suggestions of anything else which was possible. It was represented that the Greenwich street explosion occurred because a tailor rather than an engineer had charge of the box, although neither the poor tailor nor any other person had opened it for months when it exploded; that the explosion at A-pinwall originated with percussion caps supposed to be on board the vessel destroyed, and that the Hudson Co. explosion was caused by a workman thrusting a red-hot iron into the can, or by the pressure of vapor in the can generating the exploding heat.

The application of the chemical theory to the Ohio explosion is simple and satisfactory: The spontaneous

change had been going on in one or more of the packages for a long time, and the heat thus generated was confined and concentrated by reason of the non-conducting plaster, until the exploding temperature was reached. And it is probable enough that the jolting of the car brought on the explosion somewhat prematurely. If the boxes had been left quietly at the Iron Mountain the explosion might have been delayed a week or a month.

This article has now grown beyond the limits set for it, and we are obliged reluctantly and abruptly to close it.

The Sun as a Glass-Stainer.

GLASS is commonly supposed to be one of the most unchangeable of chemical compounds, and that its single weak point is its fragility. It has, however, recently been shown by Mr. T. Gaffield, of Boston, that nearly all kinds of window glass, at least, become altered in color, and that the change is not superficial but extends wherever the light penetrates. Some samples show a change in a few hours of exposure, while others hold out for years. The tints seem to be limited to purples and yellows, the purples running from pale lavender into the lilac, mulberry, flesh, amethyst, rose, violet, pink, and deep purple, and the yellows through all shades of light lemon to the brightest gold color. M. Pelouze has found that glass which has been stained by sunlight is bleached by an exposure to a red heat, and that the successive coloring and bleaching may be carried on indefinitely. The facts in the case are certainly curious, and photographers and greenhouse proprietors have opportunities to learn that they are of practical importance; indeed it is not at all improbable that they may lead to some useful improvements in the art. Mr. Gaffield has given a hint, by making pretty designs in the sensitive glass, following the method of photographic printing, and perhaps has thus inaugurated a new art of photography. The subject is of great theoretical interest, involving such questions as what are the chemical reactions which accompany the changes, and what is the character of the movements in the interchange of atoms in dry solids like glass. Although Mr. Gaffield was not the first to discover the coloring of glass by light, he has so diligently and so laboriously explored the subject, that it fairly belongs to him, and his name will be identified with it for all time. He has used a considerable part of his leisure for the past six years in the investigation, and with unflagging interest he is still planning and carrying on experiments. We are able, from a recent interview with him and an inspection of his samples of glass and of photographs, to testify to his intelligent industry and enthusiasm in the matter.

Shoe Blacking.

BLACKING, like cold punch, seems to be made up of incompatibles. Punch calls for fiery whiskey and ice (hot and cold); and sugar and lemon (sweet and sour). The receipts for blacking prescribe boneblack, composed of bone ash, say five parts (white), and carbon one part (black); oil of vitriol (sour), and molasses (sweet); and finally oil and water. Yet each of these ingredients has its specific and important office. The boneblack furnishes the blackness and the powder (carbonate and phosphate of lime), which, with the aid of the oil of vitriol, blows up, disintegrates, and pulverizes the tough, bony structure; the molasses provides for the shining, and the oil and water temper and preserve the consistency needed for use. Thus the heterogeneous elements

kindly harmonize with each other and unite in producing the happy result. It is worthy of remark that there is no free sulphuric acid in blacking, and that the sulphuric acid of blacking is innocent of the crime with which it is reproached, of injuring the leather. The sulphuric acid wholly combines with the lime of the boneblack, and thus, in effect, is put out of existence. Superphosphate of lime is, however, set free in the chemical reaction, and proof is in order of any effect thereby, good or bad, on the leather.

Butter from Milk.

A PROBLEM, something like that of how to extract blood from turnips, has, for several months past, been puzzling the chemical wits of the country. It is no less than how to produce one pound of butter out of a pint of milk and a chemical. That the problem is solved was put forth with considerable persistence by circulars and advertisements in newspapers, and opportunities have been abundant for procuring information on an investment of one dollar and upward in the chemical or in a receipt. "The Patent Butter Association" of this city, or some needy young man under that style, advertised the chemical in the form of a powder, at one dollar per box. The sceptical and facetious *Scientific American*, suggested to a correspondent that the chemical to be added to the pint of milk was probably a pound of butter; thus bringing the case into the category of practical conundrums somewhat akin to that on ram- (a sort of butter) and rod (a sort of liquor). The *American Agriculturist* indignantly pronounces the whole affair a brazen swindle, and declares that the powder of the "Patent Butter Association" resembles "cooking soda," and is of none effect in the direction of butter-making. Neither of our respected contemporaries, however, do exact justice in the premises. The chemical employed is a substance which will curdle milk, i. e., coagulate the casein of milk, and is perfected by adding to it a little yellow coloring matter and a little salt. The best known coagulator is rennet, and a sample of the chemical which we have seen was bi-sulphite of soda, and another, alum mixed with a vegetable acid. A sample of the "butter" which was brought to our office had a mushy consistency, and was a poor imitation of anything good to eat. As milk contains only about three per cent of casein, the "butter" of the "Butter Association" is nearly all water.

Patent Claims for Inventions in the Chemical Arts.

Very little information about the nature of the new inventions can be had by a study of these patent claims. Some of the claimants really believe that words were invented to conceal ideas!

ISSUED NOVEMBER 3.
83,589.—EXTRACTING SACCHARINE MATTERS FROM MALT.—William Anheuser, St. Louis, Mo. Antedated October 28, 1868.

I claim, 1st. The process of forcing a direct current of steam, water, or compressed air into a tight compartment, containing the malt, for the purpose of pressing the saccharine juice from the malt.

2d. The application of a suction apparatus to secure a ready issue of the saccharine liquor, either separately or in combination with the device specified in the first claim.

83,615.—COMPOUND FOR KILLING INSECTS ON TREES.—H. D. Flower, Chicago, Ill.

I claim the ingredients herein named, compounded and applied substantially as and for the purpose set forth.

83,648.—MANUFACTURE OF OXYD OF ZINC FROM SULPHURETTED ORES.—David Lees, Blair county, Pa.

I claim the application of a hot blast, substantially in the manner and by the process above described, to the manufacture of oxyd of zinc, whereby the oxyd is always formed in an oxidizing atmosphere, and at a temperature sufficiently elevated to decompose all injurious products.

83,684.—COMPOSITION FOR THE MANUFACTURE OF SAFETY AND OTHER FRICTION MATCHES.—William Austin, London, England.

I claim 1st. The manufacture of match-igniting chemicals and ingredi-

ents with anti-hydro matter, so as to render the same, and the igniting surfaces and matches prepared therewith, wet and damp proof.

2d. The manufacture of friction-igniting chemicals and ingredients for safety matches and their igniting surfaces, with the anti hydro matter or compound herein mentioned, and applying the same directly to or upon the natural surface of the material of boxes, match-containers, or match-igniters, of metal, china, stone, earthenware, or other similar materials.

3d. The manufacture of other match-igniting chemicals, with the anti-hydro matter or compound herein mentioned, and applying the same to matches.

83,707.—PREPARING RESIN SIZE FOR USE IN PAPER-MAKING.—Thomas Gray, of London, England. Patented in France June 30, 1868.

I claim 1st. The improved process for making size, by first bleaching the resin in a solution of warm water and salt of soda, or other alkaline salt, and mixing the same with a solution of chloride of sodium, under the conditions substantially as and for the purpose specified.

2d. Size prepared by the herein-described process as a new article of manufacture, substantially as and for the purpose specified.

83,730.—APPARATUS FOR CARBURIZING AIR.—Joseph Richardson, assignor to himself and G. W. Baker, New York City. Antedated Oct. 23, 1868.

I claim 1st. The arrangements and combination of the inclined shelves e, e', e'', and absorbing sheets, 1, 1', 1'', 1''', the upper edges of which dip into the troughs, d, d', d'', d''', substantially as and for the purpose described.

2d. The vertically-adjustable rods, g, g', in combination with the shelves e, e', e'', absorbing sheets, 1, 1', 1'', 1''', and troughs, d, d', d'', d''', constructed and operating substantially as and for the purpose set forth.

3d. The vertically-adjustable rod, g, in combination with the sheets, 1, 1', and troughs, d, d', substantially as and for the purpose described.

83,733.—RECOVERING WASTE ALKALIES FROM PAPER-STOCK AND OTHER FIBRES.—Carl Dietrich Julius Seitz, Bury, England, assignor to himself and Charles Edmund Bailliere, New York City.

I claim 1st. The general system or mode of treating the waste liquors resulting from the preparation of bamboo, cane, Esparto, grass, aff-straw, or other similar fibrous substance, as and for the purpose herein set forth.

2d. The system or mode of mixing the concentrated waste liquors with a certain proportion of soda (caustic soda, soda-ash, recovered ash, or sulphate of soda), and with quicklime, in the manner herein set forth.

83,737.—COMPOUND FOR DESTROYING INSECTS ON PLANTS, TREES, ETC.—George W. Spots, Jacksonville, Ill.

I claim the composition, substantially as and for the purpose above set forth.

83,748.—CHARGING GASES WITH VAPOURS OF HYDRO-CARBON LIQUID.—Cyrus M. Williams, assignor to Henri L. Sturart, New York City.

I claim, 1st. a gas-holder, in which is suspended or retained any suitable absorbent or capillary material, saturated with hydro-carbon liquid through which air or gases are passed for carburizing.

2d. I claim a carburizing-chamber, placed in the gas-holder tank, arranged to receive and distribute hydro-carbon liquid, through which air and gases are forced, for the purpose set forth.

83,758.—PROCESS OF PRESERVING TIMBER FROM DECAY.—Charles Brown, Albemarle county, Va.

I claim preserving or "lapidifying" wood, in the manner and with the material or materials substantially as described.

83,786.—PROCESS OF RECOVERING THE MATERIALS OF WORN-OUT PRINTERS' ROLLERS.—Joseph H. Osgood, Peabody, Mass.

I claim the process for utilizing the inner clients of discarded rollers, composition, substantially as described and specified.

NEW PUBLICATIONS.

A PRACTICAL TREATISE ON METALLURGY: Adapted from the last German edition of Prof. Kerl's Metallurgy. By Wm. Crookes, F.R.S., etc., and Ernst Rohrig, Ph.D., M.D. In two volumes.—Vol. I. Lead, Silver, Zinc, Cadmium, Tin, Mercury, Bismuth, Antimony, Nickel, Arsenic, Gold, Platinum, Sulphur With 207 Wood-Engravings. Pp. 724. 5s. London: Longmans, Green & Co. New York: J. Wiley & Son.

This seems in all respects an admirable work, and will, without doubt, take a high and permanent place in technological literature. Kerl's treatise has for a long time been the highest authority with metallurgists who were acquainted with the German language, and except for its great bulk would have before this been translated into English. The present work, however, is more valuable than any simple translation could be. The English authors have judiciously omitted that considerable part of the text of the German which pertains to assaying, and have supplied its place with descriptions of new processes for the extraction of metals.

THE VARIATION OF ANIMALS AND PLANTS UNDER DOMESTICATION. By Charles Darwin, M.A., F.R.S., etc. Authorized edition, with a Preface, by Prof. Asa Gray. In two volumes. With illustrations. Pp. 494. 5s. 3s. per vol. New York: Orange Judd & Co.

This is a work which will interest and profit all classes of readers; and any one who reads it will find that it is one of the few books which it is a duty to carefully preserve for future use. It is a mine of facts and suggestions pertaining to natural history, so curious, important and novel, that compilers will not exhaust it for centuries to come. Darwin's fame has heretofore rested mainly on his brilliant theory of development by natural selection; but this work shows him to be one of the most industrious and skilful observers and collators of facts of modern times. The work is provided with an index filling fifty-two closely printed pages.

A SYSTEM OF INSTRUCTION IN THE PRACTICAL USE OF THE BLOWPIPE: being a Graduated Course of Analysis for the Use of Students and all

those engaged in the examination of Metallic combinations. Second Edition. With an appendix and a copious index, by G. W. Plympton, A. M., Professor of Physical Science of the Polytechnic Institution, Brooklyn. Pp. 288. \$2. New York: D. Van Nostrand.

THIS is a compilation from the German of Scheerer and Plattner, and the title indicates what it was intended for. The first edition was chosen for a text-book by Professor Plympton and other teachers. This second edition has been carefully revised, corrected, and enlarged, and is now without doubt an accurate presentation and exposition of the uses of the Blowpipe.

MICROSCOPIC EXAMINATIONS OF BLOOD: AND VEGETATIONS FOUND IN VARIOLA, VACCINA, AND TYPHOID FEVER. By J. H. Salisbury, M.D. Pp. 65. \$1.00. New York: W. A. Townsend & Adams.

DR. SALISBURY has studied the subject *con amore* for over eight years, and has made more than thirty-five thousand individual examinations of blood with the microscope. This book, which is based upon so much labor, plainly sets forth his methods and his conclusions. It appears to be a very important original contribution to Pathology, Physiology, and probably to Practical Medicine. Every physician and microscopist ought to be interested in it. The work is suitably illustrated.

LIGHT: Its Influence on Life and Health. By FORBES WINSLAW, M.D., D. C. L. Oxon. (Hon.), &c., &c. Pp. 200. \$1.75. New York: W. A. Townsend & Adams.

THE object of this book is to show the importance of Light as a hygienic agent, and the author succeeds well in his argument. The sun is proved to be useful to mankind in ways that many do not dream of. The book is written in a popular style, and abounds in curious and entertaining facts. The author is evidently poorly up in chemistry, but the reader will not thereby be seriously led astray.

A TREATISE ON OPTICS: of Light and Sight Theoretically and Practically treated: with the Application to Fine Arts and Industrial Purposes. By E. NUGENT, C.E. With one hundred and fifty illustrations. Pp. 235. \$2.00. New York: D. Van Nostrand.

THE author says in his preface: "It is hoped that this treatise will be found useful, not only to artists, but to mechanics and artisans generally. As a text-book for schools and colleges for both sexes, such a treatise, coming within the means of all, has long been a desideratum." And again: "The painter and house-decorator, the milliner and dress-maker, the tailor and outfitter, will, one and all, find the principles of color and their harmonious relation clearly explained; while the sculptor, the builder, the stone-cutter, the mason, the draughtsman, the architect, the engineer—in short, all persons who may be engaged in any department of human industry—will find the work, it is hoped, worthy of careful study." And there is more of the same sort. Chapter I starts off thus: "Optics is the science which treats of vision, or seeing, and of the nature and properties of light—the changes which it undergoes, in its qualities or direction when." &c. On opening the book at random, we learned (page 208) that "the spirit level is an optical instrument used by surveyors, engineers, &c., meaning, however, the spirit level which is provided with a telescope. So also the theodolite, quadrant, and transit instrument are all described as optical instruments. If we believed in Nugent we should consider a locomotive an optical instrument, for the parabolic reflector is an adjunct about as important to it as the telescope is to surveying instruments. Mr. Nugent used his senses pretty freely, and of course he would have made a better book if he had relied entirely on them, for in his hands they are mightier than his pen. When he is moved to get up another book on Optics he should take a clean thing of it, as when we snip off a dog's tail close to his ears, and extract from any one of a score of good school books on Natural Philosophy whatever is said about Optics from A to Z inclusive. A man with faculties of intellect should never be allowed to use his own pen on a subject so venerable.

HOW CROPS GROW: A Treatise on the Chemical Composition, Structure and Life of the Plant. For all Students of Agriculture. With numerous Tables of Analysis. By Samuel W. Johnson, M.A., Professor of Analytical and Agricultural Chemistry in the Sheffield Scientific School of Yale College; Chemist to the Connecticut State Agricultural Society; Member of the National Academy of Sciences. New York: Orange Judd & Co. Pp. 394.

PROF. JOHNSON, although a young man, is already known to the public as a conspicuous leader in the Sciences pertaining to Agriculture. In all his writings he displays an industrious habit of collecting, comparing, and judiciously arranging his facts. The present work will materially increase his enviable reputation among chemists and agriculturists. It seems to be well fitted to be a text-book for Agricultural Schools, and a reference-book for teachers of Chemistry and Botany.

A TREATISE ON PHYSIOLOGY AND HYGIENE: For Schools, Families, and Colleges. By J. C. DALTON, M.D., Professor of Physiology in the College of Physicians and Surgeons, New York. Pp. 399. \$1.50. New York: Harper & Brothers. London: Sampson Low, Son, & Marston.

THIS is a comely book, elegantly illustrated with woodcuts, substantially bound, and furnished with an admirable index. We only need add that the author is one of the most eminent of American Physiologists, and an experienced and graceful writer.

Pamphlets.

EARTH CLOSETS: How to make them, and how to use them. By Geo. E. Waring, Jr., Author of the "Elements of Agriculture," and "Draining for Profit and Draining for Health," formerly Agricultural Engineer of the Central Park, New York. Pp. 45. \$0.25. New York: The Tribune Association.

THE Earth Closet is an invention by which dry earth, in a fine powder, is substituted for water in privies and urinals. The object is to add to the manurial resources of the country, and to abate some of the

nuisances of privies when the use of water is impracticable. The subject is evidently a hobby with Mr. Waring, and he thinks an earth closet commode is a very proper thing to have in every house. The pamphlet will do good in making more public the useful, absorbing and deodorizing power of dry earth.

PAPER ON BUILDING STONE. By Charles H. Porter, M.D. To the New Capitol Commissioners. Pp. 41.

DR. PORTER discourses of good and bad building stones, the causes of deterioration, and the methods of determining their value. The discussion is skillfully managed, and abounds in confirmative facts.

THE AMERICAN JOURNAL OF SCIENCE AND ARTS. Conducted by Professors R. SILLIMAN and JAMES D. DANA, &c., &c. Five November. Pp. 289 to 436 inclusive. \$6.00 per annum.

THE chemical papers in this number are: 1. On the Molecular Structure of Uric Acid and its Derivatives. By Prof. WOLCOTT GILBERT of Harvard University. The author endeavors to show that uric acid and its derivatives are members of series, the limiting terms of which are on the one side polymeric forms of cyanic acid, and on the other alcohols, or their corresponding hydrocarbons. Starting with cyanic acid (NC=O) as a foundation, by plausible substitutions and changes in the units of combination, he constructs series comprising not only uric acid and its known derivatives, but an infinity of other possible compounds. We commend the reading of this ingenious paper as a useful exercise to those who are interested in the modern theories of chemistry. 2. On the Artificial Formation of Organic Substances. By C. GREVILLE WILLIAMS, F.R.S. This is a brief report of a semi-popular lecture delivered before the Royal Institution. 3. On the Action of Sunlight on Bisulphide of Carbon. By O. LOEW, of the College of New York. Mr. Loew exposes pure (l) bisulphide of carbon in sealed tubes to the sunlight, and finds that it turns yellow, and at last a brownish insoluble substance is precipitated, which he declares to be sesquiphosphide of carbon. But the chemical world has often been deceived by alleged discoveries of a subphosphide of carbon, and Mr. Loew's position needs to be fortified by more facts than he has presented. 4. Notices of Papers in Physiological Chemistry. No. 3. By Prof. Geo. F. BARKER, of Yale College. This series of notices brings within our reach the latest discoveries and theories. Our obligation to Professor Barker is enduring and profound.

This number of the journal also contains valuable papers on the usual round of subjects. Every American ought to take pride in the continued prosperity of this venerable exponent of American science.

REPORT TO THE MANHATTAN GAS CO. on the Merits of the Lime and Iron Methods of Gas Purification. Pp. 20. New York: Office of the American Gas Light Journal.

THE conclusion to which the author (Prof. Henry Warts) arrives is that the lime purification is to be preferred. The report speaks with great favor of a method used by the Gas Co. of preventing the offensive smell when the purifiers are opened. The method consists simply in driving air through the purifiers before opening them, and carrying the same air through a supplementary purifier charged with fresh lime.

ITEMS AND NOTES.

DR. R. P. STEVENS, who has for the past six months been employed in the exploration of the gold district of Guana, Venezuela, S. A., visited this city during November. He reports the new gold discoveries to be of great importance. His memory is kept green at our office by the skin of a boa 15 feet in length, and the skin of a South American leopard.

E. W. DIMOND has entered upon his duties as Prof. of Chemistry in Dartmouth College. He will give a Course of Lectures on Pharmaceutical and Agricultural Chemistry in addition to the usual routine.

DR. C. F. CHANDLER, Chemist to the Metropolitan Board of Health, has recently, by analysis, &c., examined the Croton water, and the breadstuffs used in this city. He reports favorably of the quality of both.

E. P. HARRIS, lately of Beloit, Wis., has been appointed Prof. of Chemistry in Amherst College, to succeed W. S. Clark, now President of the Mass. Agricultural College.

H. F. WALLING, of New York, will commence his duties as Prof. of Civil and Topographical Engineering, with the new year, at Lafayette College, Easton, Pa. He intends to prepare models of the principal coal and iron mines, and give special prominence in his instruction to mining engineering.

C. H. HITCHCOCK, recently appointed State Geologist of New Hampshire, directs his attention chiefly to the mining interest, and has commenced his work by a preliminary examination of the gold district in the neighborhood of Lisbon. Prof. Hitchcock has also recently been added to the faculty of Dartmouth College. Next summer he will instruct a class in field geology.

C. A. GORESMAN, Chemist of Salt Works at Salina, N. Y., is elected Prof. of Chemistry in the Mass. Agricultural College.

E. W. ROOR, late Assistant in the School of Mines of Columbia College, has been appointed Prof. of Agricultural Chemistry in Hamilton College. We regret to learn that illness keeps him away from his new duties.

DR. G. L. GOODALE, of Saco, Me., is the new Professor of Chemistry in Bowdoin College.

A. P. ROCKWELL, Prof. of Mining in Yale College, is also Prof. of Mining Engineering in the Mass. Institute of Technology.

A. M. EDWARDS, as Prof. of Chemistry, succeeds Dr. Chandler in the College of Pharmacy, and C. P. Stone in the Medical College for Women, all of this city.

PROFESSOR JOHN LE CONTE has left the University of South California to take the professorship of physics in the State University of California.

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